ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY W. H. MAW AND B. ALFRED RAWORTH.

VOL. CIII.—FROM JANUARY TO JUNE, 1917.

London:

OFFICES FOR ADVERTISEMENTS AND PUBLICATION—35 & 36, BEDFORD STREET, STRAND, W.C.

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ENGINEERING:

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EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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VOL. CIII.—No. 2662. *LONDON: FRIDAY, JANUARY 5, 1917.* [Registered at the General Post Office as a Newspaper.] PRICE.. 6d. BY INLAND POST..8d.

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See Advertisement last week, page 69.

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SYSTEMS { PRESSURE, AIR, STEAM.
FOR BOILERS OF ALL TYPES.
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Boilers.
See page 96, Dec. 15. 5020

Improved High Pressure
RENEWABLE DISC GLOBE VALVE.
See our Advertisement in last week's issue, page 30.
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See Advertisement page 56. 4790

Several Generating Sets for
SALE from 100 to 800 KW., D.C. and A.C., usual voltages.
A.C. GENERATOR with Exciter, 260 KW., two phase, 2200 volts, 334 R.P.M., easily recoupled for other voltages.
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Fine Red Moulding Sand,
FOR
IRON, BRASS, ALUMINIUM.
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Seven years' experience in Design and Construction of Aircraft.
"THE FIRM WHO GAVE THE FLYING BOAT TO THE NAVY."
ALL BRITISH BUILT.
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Die Castings
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OF ALL DESCRIPTIONS.
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See half-page Advertisement, last and next week.

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ENGINEERS, IRLAM, MANCHESTER.
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4905
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See Full Page Advt. page 46, Dec. 15.

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Switches and
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Gas Engines, Suction Plants,
Inspections, Tests and Reports. Expert advice.—B. J. DAVIS, M.I. Mech. E., Great Eastern Road, Stratford. Telephone: East 1866; Stratford 680. Tel.: Baptizing, London. 1794

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MONOMETER MANUFACTURING CO., LTD.,
ASTON, BIRMINGHAM.
See Advertisement page 50, Dec. 29.

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 39, Dec. 22. 2662

Cement.—Maxted & Knott,
LTD., Consulting Engineers to the British Portland Cement Manufacturers, Ltd., ADVISE GENERALLY on proposed Cement Schemes FOR ABROAD. ADVICE ONLY. Highest references. Established 1895. Address, BURNETT AVENUE, HULL.
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Augustin - Normand
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Destroyers, Torpedo Boats, Yachts and Fast Boats. Submarine and Submersible Boats.
NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
5426
See half-page Advertisement page 73, Dec. 29.

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir W. FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 6169

Crystal Palace School of PRACTICAL ENGINEERING.

Principal, J. W. WILSON, M.Inst.C.E., M.I.Mech.E.—The NEW COURSE will COMMENCE on JANUARY 10th. New Students attend at the School on the morning of January 9th for registration.—Prospectus sent on application to the PRINCIPAL. F 805

The Sir John Cass Technical INSTITUTE,

JEWRY STREET, ALDGATE, E.C.

DEPARTMENT OF METALLURGY.

A COURSE of TWELVE LECTURES, accompanied by suitable laboratory work and practical demonstrations on

THE MECHANICAL TESTING OF METALS AND ALLOYS

will be given by
H. M. BOOTH,
on THURSDAY EVENINGS,
from Seven to Ten p.m.
commencing THURSDAY, 18th JANUARY, 1917.

A Detailed Syllabus of the Course may be had upon application to the PRINCIPAL. F 819

A National Need.

BRITISH SCHOOL OF AERONAUTICS. Aeroplanes and Airships. Construction, Design and Draughtsmanship. Complete Postal Courses. Also preparation for Exams. of Institutions of Civil, Mechanical and Electrical Engineers.—PENNINGTONS, 264, Oxford Road, Manchester. 6207

TENDERS.

TO MAKERS AND USERS OF STEAM LOCOMOTIVE CRANES.

The MINISTRY OF MUNITIONS are prepared to receive

Offers of Good Second-HAND STEAM TRAVELLING CRANES of various sizes.

The following information must accompany each offer, which should be addressed to Mr. HUBERT BAINES, Deputy Chief Engineer, H.M. Office of Works, Storey's Gate, Westminster, London, S.W. Type:—Lifting power, whether 2, 3, or 5 tons; radius of maximum lift; maker's name; condition; where seen; price. All for standard gauge only.

H.M. Office of Works, &c.,
11th December, 1916. F 714

TO MAKERS OF STEAM TRACTORS.

The METROPOLITAN ASYLUMS BOARD invite

Tenders for the Supply and DELIVERY to Joyce Green Hospital, Dartford, Kent, of one 5-ton STEAM TRACTOR and four 6-ton TRAILERS, in accordance with Specification prepared by Mr. T. COOPER, M.Inst.C.E., Acting Engineer-in-Chief. The Form of Tender, Contract, and Specification may be inspected at the Office of the Board, Embankment, E.C., on and after Ten a.m. on Wednesday, 10th January, 1917, and can then be obtained upon payment of £1. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender.

Tenders, addressed as noted on the form, must be delivered at the Office of the Board not later than Two p.m. on Wednesday, 24th January, 1917. F 855
(By Order) DUNCOMBE MANN,
3rd January, 1917. Clerk to the Board.

CITY OF MELBOURNE, AUSTRALIA.

SUPPLY OF ONE 7500 K.V.A. TURBO ALTERNATOR.

Tenders are Invited for the SUPPLY and DELIVERY F.O.R. and ERECTION in every way complete of ONE STEAM TURBO ALTERNATOR and CONDENSING PLANT, at the site as specified.

Tender Form, with Specification, &c., can be obtained on application to McILWRAITH, McEACHARN & Co., PTY., LTD., Billiter Square Buildings, London, E.C. Such application must be accompanied by a deposit of One Guinea, which will be returned on advice from Melbourne that a *bona fide* Tender has been received.

Extra copies of the Specification can be obtained on payment of 5s. per copy, which sum will not be returnable.

The Tender form must be filled up and returned intact, duly signed, sealed and marked "Tender for One 7500 K.V.A. Turbo Alternator," and addressed to The Chairman, Electric Supply Committee, Town Hall, Melbourne, and must be received by him before Twelve o'clock (noon) on 5th March, 1917.

Each Tender shall be accompanied by a preliminary deposit, as follows:—

AMOUNT OF TENDER.	DEPOSIT.
Up to £300	£5
From £301 to £500 ...	£10
,, £501 to £1000 ...	£15
,, £1001 to £2000...	£20
£2001 and above ...	1% of Tender price.

and in the event of his Tender being accepted, he must forthwith increase his deposit to an amount equal to Five per cent of the contract sum as a security for the due performance of the contract.

This deposit may, if desired, be handed to Messrs. McILWRAITH, McEACHARN & Co. PTY., LTD., in which case their receipt for same must accompany the Tender.

The Council does not bind itself to accept the lowest or any Tender nor will it be responsible for, nor pay for, expenses or losses which may be incurred by any Tenderer, in the preparation of his Tender.

McILWRAITH, McEACHARN & CO., PTY., LTD.,
Billiter Square Buildings,
London, E.C.
Agents for the Melbourne City Council. F 858

THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of the following STORES, namely:—

WATER CRANES.
FENCING MATERIAL.
HELICAL SPRINGS.
LAMPS and FITTINGS.
WICKS, &c.
GRINDSTONES.
ANVILS.
BOLTS, NUTS, RIVETS, &c.

Specifications and Forms of Tender may be obtained at this Office on payment of the fee for the Specification, which payment will not be returned.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Water Cranes," or as the case may be, not later than Eleven o'clock a.m., on Thursday, the 11th January, 1917.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall Avenue, E.C.
London, 3rd January, 1917. F 847

EAST LANCING SEA DEFENCES, SUSSEX.

SEA DEFENCES, CONTRACT No. 5.

The East Lancing Sea Defence Commissioners are prepared to receive

Schedule of Prices for the ERECTION of a TIMBER BARRIER and a TIMBER WAVE SCREEN, each about 1000 feet in length, on the sea frontage at Lancing.

The Drawing and Specification can be seen, and Schedule of Quantities may be obtained, at the Offices of Messrs. R. B. GRANTHAM & SON, Civil Engineers, 5, Little College Street, Westminster Abbey, London, S.W., on and after the 3rd day of January, 1917, on payment of a deposit of a cheque for £3 3s., which will be returned on the receipt of a *bona fide* Tender.

Sealed Offers, which must be on the prescribed form and endorsed "East Lancing Sea Defences," must be sent to me, the undersigned, on or before Twelve o'clock, the 16th day of January, 1917.

The Commissioners do not bind themselves to accept the lowest or any Tender.

KENNETH LOADER,
Deputy Clerk to the Commissioners.
Town Hall,
Southwick, Sussex.
3rd January, 1917. F 861

APPOINTMENTS OPEN.

TO MECHANICAL ENGINEERS.

The Ministry of Muni-TIONS announces that owing to the number of applications received in answer to the advertisement recently inserted, replies cannot be sent to each individual applicant, but only to those who are considered qualified to fill the vacancies at present existing.

Inspection Department,
Whitehall Place, S.W. F 820

Required, for Large Shop engaged in maintenance work and equipment for Steelworks and Collieries, the services of a MANAGER experienced in heavy repair work and light and heavy modern machine shop practice. Good salary to suitable man. Applicants should state age, experience, and salary required, and when at liberty. No one on Government work to apply.—Apply through your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 2783. F 795

Wanted, Shop Manager for Shell Factory; good organiser, knowledge of machining operations; good opening for suitable man. State experience. No person already employed on Government work will be engaged.—Apply, nearest EMPLOYMENT EXCHANGE, mentioning this Journal and F 771.

Machine Shop Manager WANTED, at once, for important Government Controlled Engineering Works in Yorkshire. Applicant must be fully experienced in modern machine shop practice and tools, sound knowledge of rate fixing essential, locomotive experience an advantage; must be Six o'clock man.

Nobody engaged upon Government work need apply without permission of present employers.—Apply, stating salary, age, and full particulars of experience, to your nearest LABOUR EMPLOYMENT EXCHANGE, mentioning this Journal and F 800.

Engineering Works Manager WANTED IMMEDIATELY, for controlled shop on Government work, to be greatly extended after the war. Must be experienced, energetic organizer, and thoroughly up-to-date.—Apply, stating full qualifications and salary required, to nearest EMPLOYMENT EXCHANGE, quoting No. A 2755. No one already engaged on Government work will be engaged. F 831

Wanted, Heat Expert. Salary and commission (minimum) £500 per annum. Must have practical works experience in furnace construction or brick works on kilns and boilers or in engineering works or gas works.—Address, with full particulars, F 851, Offices of ENGINEERING.

Assistant Engineer Re-QUIRED by the Government of Nyasaland for service in the Public Works Department, for one tour of 20-30 months, with possible extension. Salary, £350-£10-£400. Free quarters and first-class passages. Liberal leave in England on full salary. Candidates who have served articles with a Civil Engineer should apply at once, by letter, giving full particulars, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. A.M.I.C.E. preferred. No person engaged on Government work or eligible for the Army need apply. F 867

Wanted, by Large Ammuni-tion Factory, ENGINEER, able to take charge of hydraulic plant, including high and low pressure systems operating presses employed in cartridge manufacture. Application from experienced hydraulic engineers only considered. No one already employed on Government work will be engaged.—Apply nearest EMPLOYMENT EXCHANGE, mentioning this Journal and F 845.

Russian Engineer Required, immediately for special commercial and technical work in this country with ultimate object, if proved success, of proceeding to Russia. Applicants should give full particulars of experience and age, and should state salaries required whilst in England and also in Russia. No person on Government work need apply.—Apply, nearest LABOUR EMPLOYMENT EXCHANGE, mentioning this Journal and F 791.

Leading British Engineering Concern are PREPARED to RECEIVE APPLICATIONS from Belgian ENGINEER of proved Commercial Experience, view acting as Representative in Belgium after the war. Please state age, and give full particulars of experience and salary required. No person on Government work need apply.—Apply, nearest LABOUR EMPLOYMENT EXCHANGE, mentioning this Journal and F 790.

Chief of Buying and Contracts Dept. WANTED for important Aviation Co. in London. Must have had similar experience of large aviation or engineering works. Applications, which will be treated in confidence, should mention age, experience, present employment and salary required.—Address, F 838, Offices of ENGINEERING.

Wanted, Technical Clerical MEN for Buying, Estimating, and Progress Depts., in important Aviation Works in London. No person already employed on Government work will be engaged.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and F 837.

A Vacancy Exists for a Com-MERCIAL ASSISTANT, in a controlled Aircraft Works, employing about 500 hands. Preference will be given to a man who has held a position of responsibility in the office of an engineering works. Must be a capable organiser with a knowledge of cost keeping, general accounts, and commercial correspondence. The Applicant appointed would have an opportunity of eventually taking up an executive position in the management of the works if he proves satisfactory. No person already employed on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and F 835.

CITY OF BIRMINGHAM
(ELECTRIC SUPPLY DEPARTMENT).

APPOINTMENT OF ASSISTANT CONSTRUCTIONAL ENGINEER.

An Assistant Constructional ENGINEER is REQUIRED to assist in the preparation of specifications and plans for new buildings, and lay-out of new steam and electrical plant, and in superintending the erection and testing of such plant.

He should be familiar with the latest practice as applied to large generating stations, and should preferably have had workshop, central office, and drawing office experience.

The commencing salary will be £350 per annum, rising at the discretion of the Committee to a maximum of £300 per annum.

Forms of application, which may be obtained from the Secretary of the Electric Supply Department, 14, Dale End, Birmingham, must be filled in by the applicant, accompanied by copies of not more than three testimonials as to experience, ability, and character, and should be sent to the undersigned by January 13th, 1917.

R. A. CHATTOCK,
City Electrical Engineer.
14, Dale End,
Birmingham. F 834

THE SECRETARY OF STATE FOR INDIA IN COUNCIL will, in 1917,

Appoint a Few Natives of India as ASSISTANT ENGI-NEERS in the Indian Public Works and State Railway Departments.

Candidates must be British subjects, and, save as provided in Appendix III to the Regulations, must be not less than 21 and not more than 24 years of age on the 1st July, 1917. They must have either obtained one of certain recognised University degrees or other distinctions in Engineering, or have passed the Associate Membership Examination of the Institution of Civil Engineers.

Applications must reach the India Office by 31st March, 1917. Printed Forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, London, S.W.

India Office, London,
December, 1916. F 621

Several Good Mechanical DRAUGHTSMEN REQUIRED for Admiralty Establishment. Accustomed to small high-class work preferred. State experience, age, and present position. Salary according to ability.—Write, BOX No. 916, care of Messrs. R. F. WHITE & SON, Genl. Advng. Agents, 33, Fleet Street, London, E.C. F 864

Assistant Chief Draughtsman REQUIRED, for Engine Department of large Naval Construction Works. A wide experience of latest Admiralty practice and a good knowledge of modern drawing office organisation and management are essential. No one already on Government work need apply.—Apply, your nearest EMPLOYMENT EXCHANGE, mentioning A 2747. F 826

Two Experienced Civil En-gineering DRAUGHTSMEN REQUIRED (London). No person already engaged on Government work, or resident more than 10 miles away can be employed.—Reply, giving particulars of experience, salary, &c., to Z. C. E., care of DRACONE, Leadenhall Street, E.C. F 856

Draughtsman with thorough experience in Machine Design for large Ammunition Factory in the Midlands.—Apply, with full particulars of age, experience, and salary required to the nearest BOARD OF TRADE EMPLOYMENT EXCHANGE, quoting No. A 2791. No person at present engaged on Government work need apply. F 761

Designer, with Good Mech-anical Engineering experience, REQUIRED by Admiralty establishment for the duration of the war. No others need apply.—Reply (by letter), stating age, experience, and present salary to BOX No. 919, care of Messrs. R. F. WHITE & SON, Genl. Advng. Agents, 33, Fleet Street, London, E.C. F 866

Required, the Services of Four Skilled DRAUGHTSMEN, accustomed to either Blast Furnace or Steelworks constructional design. Good salary offered to suitable men. Applicants should state age, experience, salary required, and when at liberty. No one engaged at present on Government work need apply.—Apply, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and No. A 2739. F 786

Wanted, Mechanical DRAUGHTSMEN, aircraft experience not essential. No person resident more than 10 miles away, or already on Government work will be engaged. State age, experience, and salary, to WELLS AVIATION CO., LTD., Whiteheads Grove, Chelsea, London, S.W. F 743

Required for Temporary service in Government department, DRAUGHTSMEN with good knowledge of heating installations, gas cooking apparatus and electric lighting.—Applicants, who must be ineligible for Military service, should apply, stating age, qualifications, and experience, and salary required, to BOX 85, care of J. G. KING & SON, 10, Bolt Court, Fleet Street, E.C. F 814

Experienced Draughtsman REQUIRED, used to general engineering work, experience in design or use of testing machines preferred but not essential. Permanency and good wages to suitable applicant. Birmingham district.—Full details to F 821, Offices of ENGINEERING.

Wanted Immediately, by a Government controlled firm in the Midlands, thoroughly capable and reliable DRAUGHTSMAN, for general engineering work. State age, qualification, and salary required. No person on Government work will be engaged. —Apply in the first case to the nearest LABOUR EXCHANGE, mentioning this Journal and F 850.

Required, Young Draughts-MAN, with knowledge of civil and mechanical engineering; a gentleman invalided out of the service preferred.—Apply by letter, stating experience and salary required, to A. M. H., TILBURY CONTRACTING and DREDGING Co., Queen Anne's Chambers, Westminster. F 476

Three Capable Draughtsmen REQUIRED (London), Two with experience in mechanical engineering and lay-out of plant, and One with mechanical and electrical experience. No person already engaged on Government work, or resident more than 10 miles away need apply.—Write, giving particulars of experience and salary required, to Z.P., 935, care of DRACONE, Leadenhall Street, E.C. F 857

Wanted, for Controlled Establishment, Good Mechanical DRAUGHTSMAN, preferably with experience of machine tool design. No one engaged on Government work need apply.—State age, experience, and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and F 774.

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ENGINEERING.

WOOLWORTH BUILDING, NEW YORK.

By FRANK W. SKINNER, New York.

A VERY large proportion of all important financial, commercial and industrial industries of the United States centre in New York City, where most of them have main or branch offices.

The great railroads, mining interests, manufacturers, steel works, banks and other important institutions have responsible representatives located here. There are also here scores of miles of piers and slips, a spacious deep-water harbour, the terminus basin of the great barge canal, the outlet of the Hudson River, and the connections or terminals of many great railroad lines. All combine to give New York commercial and international advantages, which are supplemented by immense local trade and interests, and by a great number of miscellaneous manufacturers and industries located within a radius of 100 miles of the city and tributary to it.

Necessity for Extremely Tall Buildings.—The northern part of New York City proper, which is built on the long and narrow Manhattan Island, together with the other boroughs of greater New York and adjacent towns, are largely occupied by tenements and residences for the more than 5,000,000 citizens of the great metropolis. The majority of the business interests centre on the lower or southern part of Manhattan Island, where a district spoken of as the Wall Street district, and extending about six blocks north from Wall Street, contains great numbers of large banks, wholesale dealers, railroad companies, lawyers, contractors, engineers, and miscellaneous great businesses that for many years have congested its area. As a result ground has risen to a fabulous price, and the many lines of surface and elevated railroad tracks, subways and ferries converging to this point are thronged with morning and evening passengers, and the principal streets are crowded during business hours and greatly congested from 8 until 10 in the morning and from 4 until 6 in the afternoon. These conditions have resulted in excessive rental values in this district, and in order to secure them and to pay for the high cost of land and the enormous taxation, the normal ground area has been multiplied again and again by the increase in the height of the office buildings, which within about 30 years has grown from a maximum of 8 or 10 stories to one of 55 stories. There are many scores of buildings in the city with a height of more than 15 stories, a considerable number more than 20 stories high, and several having 30 stories. All of them are of the modern steel-cage construction, with exterior curtain walls supported at every storey on steel beams and columns. They are more or less perfectly fireproof and are equipped with large numbers of fast-running passenger elevators and elaborate fire protection and water supply, without which their success would be impossible. Similar structures, although generally of less extreme dimensions, are found in large numbers in Chicago and in smaller numbers in most of the other large northern cities of the United States. They have, however, their exceptional and greatest developments in New York, where it happens that the conditions of construction are by far the most difficult, in that the entire area of the congested district has a stratum of quicksand from 20 to 100 ft. deep over hard-pan and solid rock, with an unlimited amount of ground-water reaching at high tide to a distance of from 10 to 30 ft. below the surface of the street.

As most of the columns in the tall buildings have loads of from 500,000 lb. to 6,000,000 lb., their foundations, support and distribution of loads become a very serious problem, which is met in general by three different types of constructions—namely, pile foundations, surface or grillage foundations and concrete caisson foundations carried through the quicksand to rock. The latest developments of type, perfection of detail, magnitude of proportions, and improved plant for construction are illustrated by the Woolworth Building, which is the subject of this article.

General Description.—The 12,000,000 dols. Woolworth Building is a modern office building, 55 stories high, which occupies a 152 ft. by 196 ft. area on the west side of Broadway, extending a full block from Barclay Street to Park place opposite the Post Office. It is U-shape in plan, with two wings 60 ft. wide and 110 ft. long, separated by a 35 by 96 ft. interior court commencing at the fourth floor, below which the building occupies the entire area of the lot and has two additional stories extending 2 ft. below ground-water line to a depth of about 37 ft. below the curb. The 30-storey wings are surmounted by a tower 84 by 86 ft. at the base on the 31st floor, and having vertical walls up to the 40th floor, where the dimensions are reduced to 60 by 71 ft. At the 47th floor they are reduced to 60 by 61 ft. The tower is 270 ft. high from its base to the 50th floor, where it is mounted by a pyramid 105 ft. high and 64 ft square at the base, with an observation gallery above the 55th floor at a height of 730 ft. above the curb. The height from the curb to the base of the 22-ft. flagpole is 760 ft. 6 in., and from the lowest part of the foundation to the top of the building is 916 ft. 7 in. An excellent general idea of the exterior appearance of the building will be gained from Fig. 1, on Plate I, published with this issue. Fig. 2, on Plate I, is a view of the partially-constructed building, to which reference will be made later on.

The exterior of the building has a base course of granite limestone facing up to the fourth floor sill, and the balance of the walls are glazed terra-cotta. The sloping roofs are of copper and the flat roofs are of red quarry tile. The framework is supported on concrete piers carried to solid rock, and all floors and walls are carried by steel beams, girders and columns. The basement and first storey floors are of reinforced concrete 5 in. thick and act as diaphragms to distribute and resist heavy external pressures. The upper floors are of hollow flat terra arches on steel beams. The office floors are finished with cement and the corridor floors with Perraggo. The toilet-room floors on every storey are of tile and the wainscots are of white marble slabs. All corridors and office partitions are terra-cotta and steel. All stairs are iron, the corridor walls are panelled with marble and have marble trim; the exterior windows are of copper kelemein and plate glass. All doors and trim are of metal, and the main entrance is finished in marble and iron.

Equipment.—The building is provided with 24 high-speed passenger elevators and two freight elevators, besides one special passenger elevator in the tower. The longest elevator shaft is 705 ft. high, and the elevators are equipped with 26 miles of steel cables. There are provided for the service of the building six boilers with an aggregate of 25,000 h.p., 4 engines and electric generators of 1,500 kw. There are 95,000 sq. ft. of tile floor arches and 105,000 square ft. of terra-cotta partitions, together requiring 22,000 tons of terra-cotta. There are 3,000 exterior windows and 3,000 interior doors. The building is equipped with 2,000 toilet fixtures and 80,000 electric lighting outlets with 87 miles of lighting wire and cable, besides 230 miles of telephone and bell wiring. There are 43 miles of plumbing pipes in the building, and there is a water supply system provided with a total available water supply storage of 40,000 gals., besides the 42,000 gal. swimming pool reserve supply.

Occupancy.—The building contains accommodation and conveniences for about 10,000 tenants, who can work, eat, and if necessary sleep without leaving the building, or from it can eventually reach either the tube or subway lines without going from under cover. Many of the principal rooms in some of the stories were designed and constructed especially to meet the requirements of particular tenants or to cater to special interests, as rooms for the United States Court, for clubs, restaurants and for other purposes. In the basement are located a barber's shop with sanitary appliances, manicure and chiropodist parlours, a postkeller, with a dining-room seating 500 persons, and a café. Besides these there is a safe deposit vault having walls 2 ft. thick, with railroad rails, protected with a 3-in. burglar-proof lining. There are also storage rooms and 1,700 safety deposit boxes in the vault, which is protected with an electric alarm system. On the first, or ground, floor is an imposing main arcade, with 18 stores and 12 arcade booths. On the second and third floors are the National Bank, the Broadway Trust Company, telephone, telegraph and messenger service, a cigar store and a boot-black. The upper stories are generally used for ordinary offices, for great corporations and for

court rooms. The tenants are chiefly lawyers, large manufacturers, railroad companies, contractors and consulting engineers. The sub-basement of the building is not intended to be leased, and in it are installed the principal mechanical equipment, bank storage rooms, a swimming pool with a 25-ft. by 60-ft. tile-lined basin, and a complete Turkish bath equipment and rubbing room.

Sub-Structure.—The building and its contents have been estimated to have a total weight of 250,000 tons. It is located on a site where the soil consists chiefly of sand, gravel and quicksand to a depth of nearly 100 ft. below the curb and is saturated with water up to about 35 ft. below the curb. The building is carried on 61 main pneumatic caisson concrete piers with foundations on solid rock of an average depth of 116 ft. and a maximum depth of 121½ ft. below the curb. The site was previously occupied by five or six-storey brick and stone buildings, which were razed to a depth of about 16 ft. below the curb, beyond which the general excavation was continued to a depth of about 26 ft. by two one-yard clam-shell buckets loading their spoil directly into wagons on the street. To avoid obstructing the dense traffic in the congested streets here a 21 to 52 ft. wide wooden platform was built across the middle of the lot at street level, and on it were installed three elevated copper-bottom dirt storage bins, into which the spoil was dumped and from which it was chuted into trucks. Two views showing the condition of the site during the progress of the foundation work are given in Figs. 3 and 4, on Plate II, the former view having been photographed on July 19, 1911, and the latter on September 25, 1911. We also give on Plate III views of the main entrance to the building and the main corridor.

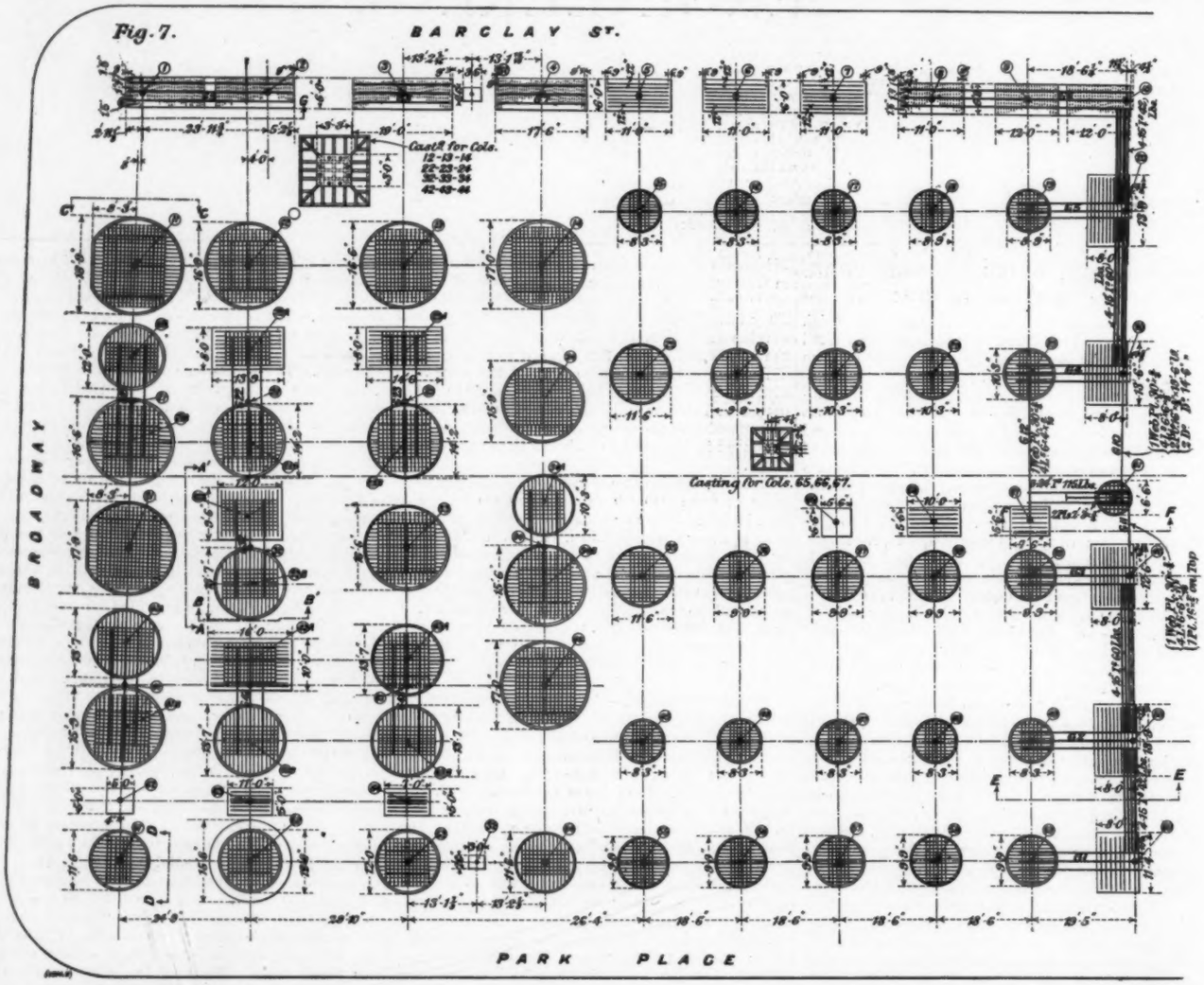
Shoring and Sheeting.—Before the excavation was carried down below the footing of a six-storey adjacent building, afterwards torn down when possession was secured for the full area of the lot, the footings of this buildings were permanently underpinned and all of the walls were shored on 24-in. I-beams used in groups of two or more and maintained on 500 jackscrews.

The 100-ft. wall of another building in the rear of the lot was shored on groups of cantilever I-beams on sills just inside the inner face of the walls and reacting at the extremities of their long arms against the opposite wall of the building, which they penetrated. The shored walls were also braced every 15 ft. by pairs of 12 in. by 12 in. inclined struts, which reached up to the second and third floor levels, having their lower ends adjustable on cribs or sills on the surface of the earth. The sides of the general excavation were retained by about 10,000 linear ft. of wooden sheeting and by about 19,000 ft. of Lackawanna steel sheet piles from 25 to 40 ft. long driven by one 4,600-lb. steam hammer, delivering 150 blows a minute, and one 1,300-lb. hammer. The 4,600-lb. hammer was seated directly on the top of the pile, without leads, and was handled by a derrick boom and five men. It drove the piles to a maximum of about 33 ft. at an average of 10 minutes each. The sheeting reacted against two horizontal lines of rangers braced by pairs of 12 by 12 in. inclined struts 60 ft. long and 12 to 20 ft. apart horizontally. The lower ends of the struts reacted against horizontal sills in the bottom of the excavation, bearing against the tops of anchor piles. When the excavation had been carried down within 5 or 6 ft. of the sub-basement floor it was discontinued, in order to expedite the sinking of the main piers, which was immediately commenced and fully occupied the entire area of the lot, so that the remainder of the general excavation was later completed under the cellar floors.

Arrangement and Design of Foundation Piers.—The centres of the piers were accurately located by transit lines and steel tape measurements from points fixed in the street. Most of the piers have a circular cross-section, except those along the Barclay Street front, which have narrow rectangles to avoid projecting beyond the building line. The distribution of the piers is clearly shown by the plan Fig. 7, given on the present page.

The piers are arranged in ten parallel longitudinal rows and in nine parallel transverse rows. The distance between the rows varies from about 10 to 30 ft., corresponding in general to the spacing of column centres. The circular piers have diameters varying from 6½ to 19 ft., while the lateral dimensions of the rectangular piers vary from 6 to 19 ft. The long and narrow piers are located at the rear of the building, where their dimensions are selected so as to give the required bearing area without projecting into the adjacent lot, and on the Barclay Street front, where recent municipal regulations prohibited their projection beyond the building line and it became necessary to make them almost as thin as sections of walls to keep them within the

Fig. 7.



lot limits. These municipal restrictions had not been imposed until after the construction of the piers on the other street fronts, which were allowed to project beyond the building line.

The irregular dimensions and arrangement of the piers under the tower are due to the fact that when construction was commenced the building was designed to occupy only a portion of the Broadway front adjacent to Park Row—later on the area at the corner of Broadway and Barclay Street was added to the remainder of the lot, giving it the width of a full block on the Broadway front, and the design was modified to correspond. In order to utilise the piers already built, which were inadequate to carry the increased loads from the extended superstructure, extra piers were sunk between those already located, and the columns were in some cases supported on two piers by means of heavy girders spanning the latter. Wherever possible, piers were made with circular cross-sections for theoretical economy and to secure the maximum area with the minimum periphery.

All of the piers are of the pneumatic caisson type and had reinforced concrete shells built on the surface of the ground in the cellar excavation. They were built solid, except that a working chamber was hollowed out of the base and provided with a communicating shaft extending up through the main body of the pier to the top. The piers were sunk by interior hand excavation and undermining, and after they reached satisfactory bearing on bed rock were filled with solid concrete, thus becoming monolithic shafts transmitting the column loads through quicksand, water, gravel and boulders to the solid rock. The heights of the piers vary from about 65 to 68 ft., and the tops of many of them are at a level from 2 to 6 ft. below ground-water elevation. The cross-sectional areas of the piers vary from 33 to 269 sq. ft., and their total estimated loads vary from 470,000 lb. to 9,423,000 lb., the latter amount being imposed on pier 11, 19 ft. in diameter, on the Broadway front, which was calculated to sustain 1,960,000 lb. floor load, 4,877,000 lb. wall load and 2,586,000 lb. wind load. The maximum estimated total load per square foot on the concrete cross section and on the rock-bearing is about 16,000 lb., which, however, is considerably greater than the heaviest actual load on account of the excessive allowances for floor loads and for wind loads, which will probably never be realised, and on account of the support derived from skin friction on the sides of the piers.

Increasing Working Space.—As about 25 per cent. of the total area of the lot, and a much higher proportion of the lot near the Broadway front, is occupied by the piers themselves, and as it was considerably obstructed by the long transverse braces required to support the retaining walls on the sides of the excavation, there was little room and less convenience for the installation and operation of the extensive plant required for the construction of superstructure and for the handling and storage of material, all of which had to be conducted without any interference with traffic, obstruction to the congested and comparatively narrow streets adjacent to the building on three sides, or danger to the thousands of people continually passing on the sidewalks.

Additional space and convenient working facilities were therefore afforded by the construction of a temporary heavy wooden platform supported on trestle bents, which extended across the middle of the lot at street level and furnished a driveway communicating with the streets for trucks to deliver materials and remove the spoil from the excavation. As the work progressed the platform was cut away in some directions and extended in others, so as to cover, first and last, a considerable portion of the entire area of the lot, and still provide open space necessary for construction purposes.

Location of Construction Plant.—Adjacent to the platform there was built on each side a framed trestle supporting a wide-gauge track on which travelled a tower derrick with four long and powerful booms commanding both sides of the lot. Other stiff-leg derricks were installed on the platform, and with the travellers served the entire area and handled the plant as it was installed, shifted and removed, built the platforms themselves, and loaded and unloaded materials. The derrick booms also operated the clam-shell buckets with which most of the earth and sand was excavated down to a depth of 26 ft. before the construction was commenced. The top soil, excavated by hand, was hoisted by the derricks and, like that from the clam shells, was deposited in the large hopper bottom storage bins elevated above the working platform, from which the spoil was delivered by gravity to trucks and removed at all hours of day and night through the city streets.

The reach of the traveller booms was so great that the derrick towers themselves did not require to be moved very much, and the space under one of them was utilised for the location of the air-compressor plant. The concrete mixers were installed below the platform and were charged by gravity, cement and aggregate being delivered and stored above them. Storage, shops, and offices of a temporary nature, as well as quarters for compressed-air workmen, were built of light wooden construction and temporarily located wherever convenient in the bottom of the excavation under or above the platform, and were shifted from place to place by the derricks as required to clear the work.

A large amount of space in the excavation and on the platform was also required for the storage of materials, thus very much crowding not only the original space, but all the additional room that had been provided by the platform construction. Even this did not suffice for the execution of the work, which was greatly congested, and it became necessary to shift materials, plant and equipments from time to time as the work progressed, and to pile them up over finished work and clear off other spaces for the new piers. After the first set of piers were built the derricks were moved to command a second section of the lot and piers within their new reach were built; then the derricks were again moved to a position over these piers and commanding the remainder of the lot, so that a third movement was not necessary.

During the construction of the piers it was twice necessary to move a 175-h.p. vertical boiler weighing 18 tons. Steel ropes were passed through the boiler tubes and connected to the derrick, which raised it enough for the insertion of horizontal rollers below the boiler, on which it was moved into the required position, the boiler raised by the derrick, the rollers removed and the boiler set down on its new foundation.

(To be continued.)

THE USE OF PULVERISED COAL.

A PAPER on this subject recently read before the American Society of Mechanical Engineers, New York, by J. E. Muhlfeld, opens with an introductory remark to the effect that, next to labour, the largest single item in the matter of expenditure for railway traffic is the cost of the fuel used in the locomotive. This consideration led the author to investigate how far the use of pulverised fuel would assist in improving steam railway operation. The results obtained were satisfactory from every point of view, so much so, in the words of the author, that steam locomotives will by the use of such fuel be placed approximately on a level with electric service; this fuel will, further, eliminate smoke, soot, cinders, sparks and fire hazards, reduce noise, time for dispatching at terminals and stand-by losses; and increase the daily mileage by producing longer runs and more nearly continuous service between general repair periods.

In Mr. Muhlfeld's view, therefore, traction by a steam locomotive using pulverised fuel is on a par with electric traction; but since he also states that the general use of electricity for the movement of heavy traffic over long distances is precluded from both an engineering and an operating standpoint, owing to the extraordinary expenditure required for first cost, fixed charges, and combined maintenance and operation, let alone the question of reliability and flexibility in motive power, there would be no comparison between the two. In the author's showing, therefore, the question would resolve itself into one of fuel saving, a matter sufficiently important in itself to justify attention being called to Mr. Muhlfeld's investigations. The problem is one of great moment. The locomotive fuel expenditure for steam railways in the United States approximates at the present time to 60,000,000*l.* per annum; about one-third of this total forms the proportion spent to kindle, prepare, clean and maintain fires on the engines. The price of coal fuel is on the increase, and the necessity of husbanding the mineral oil resources of the country, combined with other demands made upon liquid fuel, will soon eliminate that fuel from locomotive service.

According to the investigations made and referred to by the author, any solid fuel having, in a dry pulverised form, two-thirds of its content combustible, can be used for generating steam. Anthracite, bituminous and semi-bituminous coals, lignite and peat, anthracite culm, dust and slush, bituminous and lignite slack, screenings and dust, are all suitable for burning in pulverised form. The best results are obtained when these fuels are mechanically dried and crushed, their dryness and fineness being comparable to those of Portland cement, the moisture not exceeding 1 per cent., 95 per cent. of the total passing through a 100-mesh screen and 85 per cent. of the total passing through a 200-mesh screen. For a railway coaling station of average capacity the total cost of preparing suitable pulverised fuel is estimated at about 1*s.* per ton; the pulverised coal fuel should be handled with the same care as oil fuel. The fuel in its pulverised form is supplied to the tender from overhead storage bins, at the rate of 15 tons in three or four minutes, without exposing the fuel to the atmosphere during its conveyance.

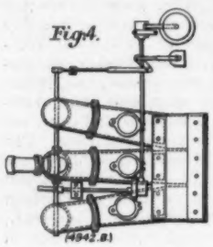
TABLE I.—*Performance of Ten-wheel Type of Goods Locomotive.*

Item.	Pulverised.		
	No. 1. Bituminous.	No. 2. Bituminous.	No. 3. Bituminous.
Fineness, per cent., through 200-mesh	85	85	85
Moisture, per cent.	0.40	0.81	0.59
Volatile matter, per cent.	24.72	36.27	24.36
Fixed carbon, per cent.	68.43	58.22	65.05
Ash, per cent.	6.85	5.44	10.59
Sulphur, per cent.	1.96	0.68	0.84
British thermal units, per lb.	14,739	14,334	13,912
Miles run, total	1,324	426	398
Cars per train, average	61	65	60
Adjusted tonnage per train, average	1,719	1,808	1,759
Speed when train was in motion, miles per hour, average	26	25	24
Boiler pressure when using steam (200 lb.), average	198.3	193.5	194.9
Front-end draught when using steam, inches of water, average	7.15	7.79	6.69
Fire-box draught when using steam, inches of water, average	3.50	3.22	3.18
Temperature of steam, degs. Fahr	562	573	555
Coal fired per hour of running time, lb., average	3,275	3,063	3,457
Adjusted ton-miles per lb. of coal, average	12.84	13.97	11.59

The prepared fuel gravitates from the enclosed fuel bunker on the tender to conveyor screws, which carry it to the fuel and pressure-air feeders, where it is thoroughly commingled with the pressure-air and carried by it through connecting hose to the fuel and pressure-air nozzles and blown into the fuel and air mixers. Additional induced air is supplied in the fuel and air mixers, and this mixture, then in combustible form, is drawn into the furnace by the smoke-box draught. The flame produced at the time the combustible mixture enters the furnace obtains its average maximum temperature—from 2,500 to 2,900 deg. Fahr.—at the forward combustion zone under the main arch; at this point auxiliary air is induced by the smoke-box draught to finally complete the combustion process. The liquid ash runs down the under-side of the main arch and the front and sides of the forward combustion zone of the furnace, falling into the self-clearing slag pan, where it accumulates and is air-cooled and solidified into a button of slag which can readily be dumped. Each of the fuel and pressure-air feeders has a capacity range of from 500 to 3,000 lb. of pulverised fuel per hour; as from one to five of these can easily be applied to the ordinary tender, there is no difficulty in meeting any desired boiler and

super heater capacity. The steam can be maintained within a variation of 2 lb. of the maximum allowable pressure, without blowing-off.

For firing-up the engine, the steam blower is turned on in the stack, a piece of lighted waste is introduced through the fire-box door and placed on the furnace floor just ahead of the primary arch, after which the pressure fan and one of the fuel and pressure-air feeders are started. It takes from 45 to 60 minutes to get up a 200-lb. steam pressure from boiler water at 40 deg. F. After firing-up, the fuel and air supply are adjusted to suit the requirements; the stack blower is operated only when the engine is not using steam.



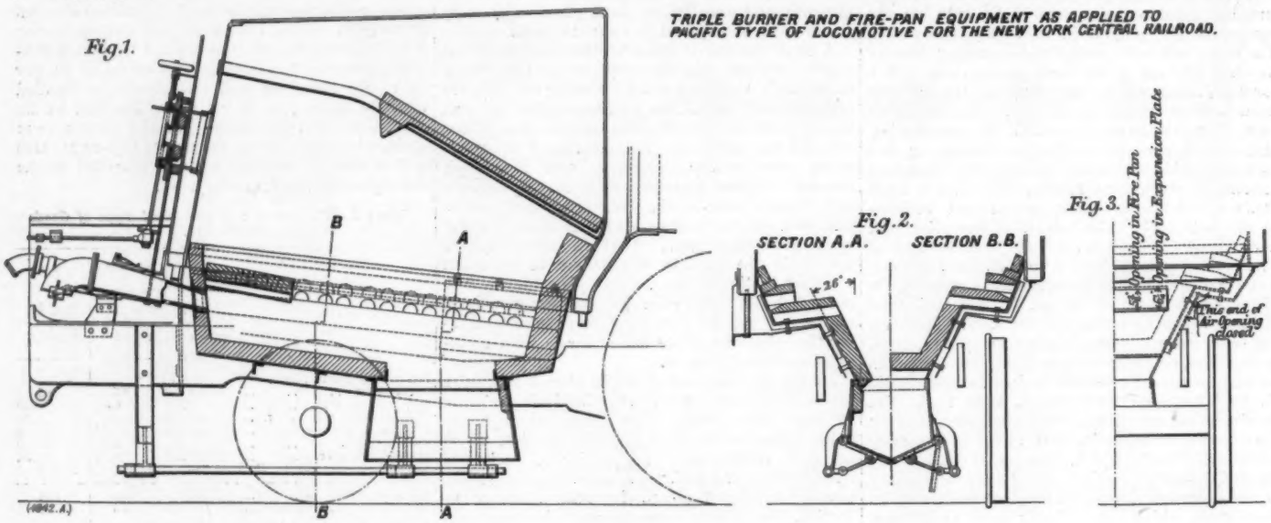
pressure, the latter being maintained at full speed with the injector supplying the maximum amount of water to the boiler. With the highest sulphur coal, No. 1, and the highest ash coal, No. 3, there was less than 1 cub. foot of slag in the slag box at the end of each run, and practically no collection of ash or soot on the flue or fire-box-sheets. In fact, with the No. 3 fuel there was less than two handfuls of slag, ash and soot collected on each trip.

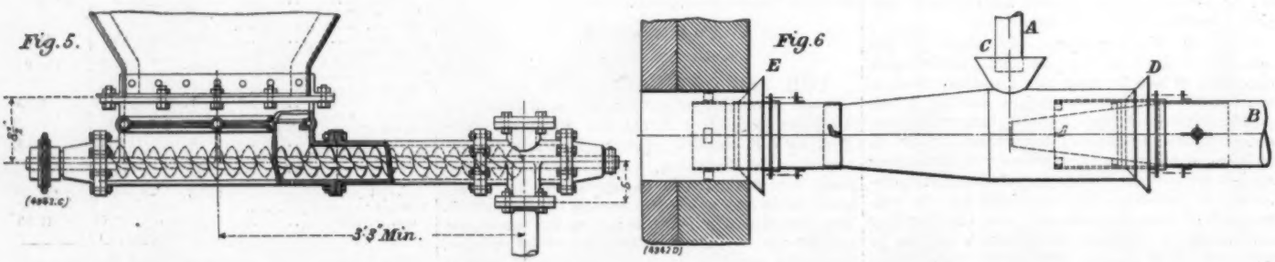
From tests made with pulverised lignite, having an analysis of about 1.8 per cent. of moisture, 47 per cent. of volatile matter, 41 per cent. of fixed carbon, 9.5 per cent. of ash, and 0.75 per cent. of sulphur, with a heating value of 10,900 British thermal units per lb., in regular passenger locomotive service, the same satisfactory results were obtained as with bituminous coals, the combustion and operating being entirely smokeless, sparkless and cinderless, and the steam pressure being fully maintained.

Figs 1 to 4 show a triple burner and fire-pan gas producers, and the substitution of pulverised coal for producer gas gave, in most instances, an increase in output which might amount to between 10 and 40 per cent., according to the nature of the practice and plant. Another advantage was that a pulverised coal installation cost less than one of gas producers. It was believed further—and this is important from the steelmaker's standpoint—that there would be from 1 to 2 per cent. less oxidation in pig-iron and scrap in melting down a heat from the cold state. The best coal for the purpose was a bituminous coal as high in volatile matter as possible, and preferably low in ash. A coal having 0.64 per cent. of moisture, 35 per cent. of volatile matter, 50 per cent. of carbon, 5 per cent. of ash, and 1.36 per cent. of sulphur gave excellent results. A coal of this analysis had a heating value of 14,200 British thermal units.

The difficulty in the case of pulverised fuel in open-hearth practice appears to be the ash problem. Ash was not found to deposit on the slag in any great

TRIPLE BURNER AND FIRE-PAN EQUIPMENT AS APPLIED TO PACIFIC TYPE OF LOCOMOTIVE FOR THE NEW YORK CENTRAL RAILROAD.





The use of pulverised fuel, besides eliminating smoke and the other disadvantages above alluded to, is stated to increase the drawbar horse-power hour per unit of weight, to improve the thermal efficiency of the locomotive as a whole, to reduce the non-productive time at terminals, to utilise otherwise unsuitable or waste fuels, to reduce labour, and to provide greater continuity of service and produce more effective and economical operation and maintenance. The figures given in Table I, on the previous page, relate to a ten-wheel type of goods locomotive, rated at 31,000-lb. of cylinder tractive power, with driving wheels 69 in. in diameter, when used on fast through goods service, on runs of from 91 to 138 miles in length, for the purpose of testing various fuels under identical adjustment conditions.

The engine was worked at its maximum capacity on all trips, about 10 per cent. more tonnage being hauled than usual for like engines burning coal on grates and at practically fast-freight schedule speed. The exhaust-nozzle opening was about 25 per cent. larger than the maximum for hand-firing. The general results were excellent, particularly as regards tonnage, speed, combustion and steam equipment as applied to a Pacific type of engine for the New York Central Railroad.

The question of the use of pulverised coal also formed the subject of a paper read at a recent meeting at St. Louis of the American Iron and Steel Institute, by Mr. J. W. Fuller, who stated that probably the greatest recent development in this direction was its application to open-hearth furnaces. Pulverised coal had been applied very satisfactorily within the last few years to various kinds of metallurgical heating furnaces and to soaking pits. In regard to open-hearth furnace practice, observations had shown that pulverised coal gave a more regular supply of heat than producer gas; they had demonstrated, further, that it was much easier to burn powdered fuel to gas than to gasify coal in the ordinary gas producer. The gas was of a more even chemical composition, and a direct result was a greater number of yields per week. Open-hearth furnaces were in operation to-day, using powdered fuel, having a very low fuel consumption, equal to the best producer-gas practice and much better than the average of the older producer-gas plants. Coal could be pulverised and delivered to the furnace at a little more than half the cost of that required for quantities, but a large quantity of ash was formed, and this had to be dealt with. The discussion on Mr. Fuller's paper revealed the important fact that the use of pulverised coal demanded the provision of suitably designed checkers and slag pockets. In regard to the economy of the system, this was confirmed, actual experience having shown that with the use of pulverised coal a furnace used from 100 to 150 lb. of coal less than the producer-gas furnace per ton of ingots cast. There was no appreciable difference in the life of the two types of furnace, and the average time of heats, using pulverised coal, was from 1½ to 2 hours shorter than when using producer gas.

The paper in question by Mr. Fuller also dealt with the construction of the open-hearth furnace and with the preparation of the pulverised fuel. This latter is kept in dust-tight bins. It is essential that the feed of the coal to the burner be under the absolute control of the furnace operator and be positive at all times, for if the feed to the burner were not absolutely regular and positive the efficiency of combustion would be materially lowered and puffing at the furnace would take place. Fig. 5 shows a type of feeder which gives excellent results.

The fuel enters the feeder through a large hopper which is fastened to the bottom of the storage bin containing the supply of pulverised coal for the furnace; it is driven forward by a long screw conveyor, which has a neat fit inside its housing, so as to prevent any flushing of the pulverised coal.

The burner used is illustrated in Fig. 6. The coal from the feeder is discharged into the pipe A. Air at a pressure of a few ounces per square inch enters the pipe B and produces an injector action which draws the coal and air into the burner through the opening at C; it also induces air at D, the amount so drawn in being controlled by a cone, while any additional air required for combustion is induced at E on the furnace wall, where control is also effected by a cone regulator.

A compressed-air jet is inserted in the nozzle of the burner, which serves to mix properly the coal and air. In this device the proper amount of air for combustion, of which about 75 per cent. is supplied through the regenerator or recuperator of the furnace, can instantly surround each particle of coal, producing ideal conditions for immediate and complete combustion. The burner being provided with a flexible nozzle, the flame can be directed to any part of the furnace, and the length of the flame can be controlled within wide limits by acting upon the two different air pressures, *i.e.*, the volume air and the high-pressure air, and also upon the quantity of fuel delivered to the burner. One such device is provided on each side of the furnace, and reversing is easily and rapidly carried out.

INDUSTRIAL NOTES.

THE Minister of Munitions announces that 39 additional establishments have been declared controlled establishments, making the total number now 4,623.

Dealing with the unrest in the cotton industry, the *Textile Mercury* states that the applications being pressed by the operatives at present are not at all unusual during the festive season of goodwill. The Cardroom Amalgamation have not let the grass grow under their feet since their recent demand for an advance in rates of pay led to that section of the industry being placed under No. 1 of the Munitions of War Act. They were then left, along with the Masters' Federation, with one of three methods of settling the dispute. It could be submitted to the Committee on Production, or to a Court to be made up of an equal number of representatives of employers and workpeople with an independent chairman, or to an individual arbitrator appointed by the Board of Trade or accepted by the Department.

An effort was made to arrive at an agreeable basis at a joint meeting of representatives of the Cardroom Amalgamation and the Employers' Federation on December 22, but the conference was inconclusive. The delegates of the operatives' organisation also conferred with the Committee of the Cotton Spinners and Manufacturers' Association (of North and North-East Lancashire), but again the parties failed to arrive at a common understanding. Later, the Amalgamated Association of Operative Cotton Spinners held their quarterly meeting, and decided to send in an application for a 20 per cent. increase. The agreement formulated by Sir George Askwith on June 10 last terminated on December 31, and in the ordinary course of events six weeks should have transpired in the New Year before notice of a change in wages could be given. The cardroom hands, however, raised a dispute several weeks before the termination of the year, and the operative spinners have now intimated their intention to follow suit.

No official account has been given to the public of the reason why the arrangements between the employers and the cardroom workers broke down. It has been stated that the latter were anxious to select Mr. John Hodge, M.P., the Minister of Labour, as the arbitrator. The masters preferred Sir George Askwith, who has dealt with cotton disputes on several occasions and usually granted half of the excessive demands of the operatives. But the cardroom representatives, having already disobeyed his decision of June 10, did not agree with the selection of the employers. Hence the deadlock. The Board of Trade will be acquainted with the views of each side, and in all probability will proceed to adopt their own means of investigating and deciding the whole question of wages. In the end the consumers will have to pay the cost. When the world situation of the cotton industry is taken into consideration, along with the importance of maintaining the value of the Lancashire industry from an export point of view, the arbitrators should perceive the necessity of dealing very carefully with the problem. Under the Munitions Act they will have the power to enforce their decision without the consent of one side or the other, and make the offenders bear the penalty of disobedience.

The annual report for 1915 of the Secretary of Mines for Victoria states that the output of coal during the year was 588,104 tons, valued at the pit's mouth at 274,770*l.*, or 9*s.* 4*d.* per ton. Brown coal to the extent of 2,864 tons, valued at 573*l.*, was raised at Altona by the Melbourne and Altona Colliery Company. The total of 588,104 tons shows a decrease of 29,432 tons on the output for the previous year. The coal mines gave employment to 1,303 men. Of the total of 588,104 tons, 528,922 tons proceeded from the State coal mine, of Wonthaggi. The total value of the minerals raised in Victoria during 1915 amounted to 1,737,158*l.*, in which gold entered for 1,397,793*l.*, the next largest figure being the above figure for coal, followed by 49,320*l.*, the value of the antimony ore.

In a paper read by Mr. W. N. Polakov before the meeting of the American Society of Mechanical Engineers, held at the commencement of last month, a statement is made to the effect that at the outbreak of the war the United States was rushing headlong into a period of industrial depression, caused by surplus production which could not be consumed in the country on account of the small purchasing capacity of the people, and which could not be exported because poor shop methods prevented the American works from producing as cheaply as other countries. The undeveloped stage of the American credit system contributed a further obstacle to the development of export. There was, added Mr. Polakov, no incentive for America to plunge into the war, since there were no foreign markets to fight for, neither could anything be gained by a territorial expansion. A crisis seemed imminent, but European orders postponed it.

At a meeting held in London on the 21st ult. the Triple Industrial Alliance (Miners' Federation of Great Britain, National Union of Railwaymen and National Transport Workers' Federation) passed the following resolutions:—

"That, in view of the Government's statement to guarantee the selling price of wheat at 60*s.* per quarter, this Conference calls for action upon the part of the Government to guarantee a minimum wage of 30*s.* per week, exclusive of payment in kind, to all agricultural workers, and that women on the land shall have an assured minimum similar to those women employed in the production of munitions."

"That this meeting strongly objects to the sinister movement which is now in operation to import coloured labour into this country, and expresses its irrevocable opposition to any and every effort in this direction, and further calls upon the whole organised labour movement of Great Britain to take steps immediately to stop the movement."

"That this meeting protests against the extended use of Chinese and other Asiatics in Admiralty transport ships and the mercantile marine in general unless and until the services of British seamen and seamen of friendly alien nations have been utilised to the fullest extent. In the event of Chinese and other Asiatics being required to fill any shortages in Admiralty transports or in the mercantile marine they shall receive equal pay and conditions with white seamen."

"That this meeting, recognising the vital importance of the mining, railway and transport services being maintained in a state of efficiency, demands that adequate steps be taken to prevent any further depletion of these services, and protests against mobile battalions under military control being formed to do civilian work; and, further, declares that no system of releasing men from His Majesty's forces to resume their ordinary work in any of these industries can be accepted which does not secure to such men full civilian rights."

In a recent report issued by the Special Committee of the London Chamber of Commerce on Trade during and after the war, the following recommendations are given as a basis for negotiation between capital and labour:—

"(*a*) As regards the remuneration of employees, the principle of payment by results should as far as possible be adopted by employers and employed.

"(*b*) The basis of rates of payment for labour should involve such a scale as will ensure for all willing and efficient workers a fair and reasonable standard of living.

"(*c*) The Government should afford opportunities for considering the amendment of the Trade Disputes Acts and of any provisions of the Factory and Workshop Acts other than those relating to the health of the workers.

"(*d*) Encouragement should be given, as far as possible, to profit-sharing and co-partnership agreements, or premium and bonus systems on lines which have proved beneficial to employers and employed in the past, subject to the special conditions of particular trades, and to the maintenance of the standard rates of wages."

In the same report the committee enumerates as follows other points which it says will have to be dealt with in due course, in connection with the development of industry after the war:—

"(*a*) The utilisation, for the purposes of private enterprise after the war, of factories now engaged in the production of munitions in connection with industries for which they may be suitable.

"(*b*) The encouragement of the technical education of younger employees by giving them greater facilities for attending the necessary classes beyond the statutory school age.

"(*c*) The amendment of the Patents, Designs, and Trade Marks Acts so far as they may be restrictive of the adoption of new processes, labour-saving appliances and new inventions.

"(*d*) The improvement and cheapening of means of transport by rail, road and waterways, including canals.

"(*e*) Increased facilities for obtaining information through Government Departments regarding competition in the markets of the world and new openings for the sale of British goods.

"(*f*) Such further direct representation of manufacturers, individually and collectively, in the Dominions, allied and neutral countries, as may be in harmony with the legitimate interests of the merchant.

"(*g*) A more sympathetic attitude on the part of the Government in regard to the promotion and amendment of legislative measures affecting British industry, especially in relation to conditions of labour.

"(*h*) A preference on the part of Government Departments and local authorities for goods produced within the British Empire when needed for the requirements of the State."

Sir J. P. Maclay, the Shipping Controller, has appointed a committee, consisting of the following gentlemen, to advise him on all matters connected with the acceleration of merchant ships now under construction and nearing completion, and with reference to the general administration of a new merchant shipbuilding programme to be undertaken by the Controller:—Mr. George J. Carter (of Messrs. Cammell, Laird and Co., Limited), President of the Shipbuilding Employers' Federation (chairman); Mr. W. S. Abell (Chief Surveyor to *Lloyd's Register of Shipping*); Mr. F. N. Henderson (of Messrs. D. and W. Henderson and Co., Limited); Mr. James Marr (of Messrs. J. L. Thompson and Sons, Limited); Mr. Summers Hunter (of the North-Eastern Marine Engineering Company, Limited); Mr. C. J. O. Sanders (of the Marine Department, Board of Trade); and Mr. W. Rowan Thomson (of Messrs. D. Rowan and Co.), President of the North-West (Clyde) Engineering Trades Employers' Association.

Mr. A. R. Durnan, secretary to the Shipbuilding Employers' Federation, 28, Victoria-street, Westminster, will act as secretary to the committee.

STEEL PRICES.—In connection with the dealing in steel, under permit from the Ministry of Munitions, notice of modification in certain prices has been made. Maximum basis prices for steel per ton net f.o.t. maker's works are thus changed:—

	£	s.	d.
Mild steel diamond pattern chequer plates—			
¼ in. thick on plain and over ...	13	10	0
Under ¼ in., but not under $\frac{5}{16}$ in. on plain	16	5	0
Subject to List of Extras "J," dated January 1, 1917.			
Higher high tensile steel—			
Plates 10 lb. thick and up ...	22	0	0
Subject to List of Extras "K," dated January 1, 1917.			
Angles 7 united inches and over	21	0	0
Subject to List of Extras "L" dated January 1, 1917.			

The prices of steel scrap sold without guaranteed analysis, per ton, is as follows:—

	£	s.	d.
Heavy steel melting scrap ...	5	5	0
Steel turnings and borings ...	2	10	0
Special short extra heavy steel turnings	3	10	0

All these prices for steel scrap are free on rail or free in barge at the nearest convenient siding or wharf to the place where the scrap lies at the time of sale: the carriage at actual cost or at a fair average rate agreed between the seller and buyer may be charged to the buyer up to a maximum of 10*s.* per ton. The maximum prices above referred to for steel scrap sold with guaranteed analysis is as follows, per ton:—

	£	s.	d.
Heavy steel melting scrap—			
Not over 0.04 phosphorus and sulphur	6	5	0
Not over 0.05 phosphorus and sulphur	6	0	0

HIGH-PRESSURE STEAM STOP VALVES.

*The Design and Construction of High-Pressure Steam Stop Valves.**

By D. MACNICOLL (Member).

IN designing high-pressure steam stop valves the essentials to be observed are: Tightness, reliability, simplicity, and safety. In small sizes not exceeding 4 in. or thereabouts and of single-beat type these essentials are obtained without much call for special consideration, but as the sizes increase the design demands careful attention. In the succeeding columns an investigation of the various designs is contributed, and prominence given to details which affect what might be termed the general efficiency and safety of the fitting.

Fig. 1 shows a type of single-beat unbalanced stop valve frequently used as a boiler stop. The same design in more or less modified form is used throughout most main steam-pipe systems, being met with as an intermediate shut-off or bulkhead stop valve. The valve shown is of 8 in. diameter, the material of chest being cast-iron, internal parts gunmetal, and the working pressure 200 lb. per square inch. In many instances chests of this size and for this pressure are made in cast steel, but provided the design is carefully observed the choice of material is optional. For larger sizes or higher pressures cast steel is desirable. Independent of pressure, wherever superheat is present, cast steel is essential, and the internal fittings in this instance should be of a high-tension bronze, preferably a nickel alloy.

The features in the design which call for special attention are: stresses in the chest due to pressure; stresses due to hardening down; stresses due to expansion of spindle with valve shut; tendency of valve to rotate when steam is flowing through; liability to fracture of seat studs. In settling the thickness of body metal the general method is to ensure that the aggregate section is such as to allow of a safe stress per square inch of section, but on investigation it is readily admitted that all parts are not equally stressed.

In Fig. 1, assuming that the pressure is present throughout the chest and acting at right angles to the plane of section shown, the stress on the part lettered A is much higher than on the other portions. By way of illustration:—The pressure on the upper half of the outlet and half the cover is approximately 8,950 lb., which stresses the section on the top left-hand side to 1,061 lb. per square inch, whereas the average stress for the aggregate section is only 891 lb. The cover, of course, takes a portion of the stress due to frictional resistance, and the tighter the cover nuts are screwed up the greater the assistance given to the weaker section. In a sense this is "robbing Peter to pay Paul," as it simply puts up the stress on the studs.

The stresses resulting from excessive hardening down are in many instances exceptionally high, as is often proved by the burst condition of valve lids. This hardening down is due to an attempt to overcome leakage. It appears providential that the valve lid gives way in nearly every case, or otherwise there might be far more fatal accidents in this connection. Steel crossheads and turned pillars should always be fitted in preference to cast bridges, the latter being anything but safe, particularly in the larger sizes. There is no doubt that in valves over 4 in. diameter a great benefit accrues from the adoption of a flexible seating in conjunction with the solid face. This was introduced by Messrs. R. R. Bevis, J. H. Gibson and Cockburns, Limited. With this arrangement leakage from distortion is obviated, and in addition there are two faces, so that if one is leaking from any cause outside of distortion there is always the other one to fall back upon.

Another source of high stress is when the valve has been shut down hard when cold and afterwards steam from other boilers admitted to the top of the body. Even with steam in the inlet side only a fair degree of heat is transmitted to the spindle. In each case the subsequent tendency to expansion puts a stress on all the parts. An actual experience of the authors is illustrated in Fig. 2. This was a double-beat type of valve and the bottom seat was attached as shown. The valve was hardened down for a steam test, with the result that after the test a number of the manganese bronze studs from the bottom seat were found lying broken in the bottom of the chest, and all showed signs of fracture, the expansion of the spindle having caused this. Apart from this, the design of seat is not to be recommended even if the studs do not give way, as the tendency thereby is to cause a leaky joint between chest and seat. Seats should be arranged where valves have to be hardened down so that this hardening tends to make the joint tighter, that is to say the gunmetal seat should be upon the top of the steel seat, and not below it as shown. One method of counteracting the damage from expansion is by fitting a spring crosshead. This is shown in Fig. 3, and is loaded generally from 1½ to 1¾ times the boiler pressure per square inch of valve area, and a higher load than this cannot be put upon the valve spindle, no matter what purchase is used. In Fig. 1 stays are sometimes fitted as shown dotted. These only serve to stiffen the cover and, as will be noticed, still further reduce the section of metal at an already weak section.

The rotation of winged valves when steam is flowing is due either to a slight angle on the wings or to eddies in the steam. The valve can be prevented from rotating, but to do this a pin must be fitted or other means adopted. The damage done to valves from this rotation is hardly credible, and calls for the adoption generally of pintle or centre-guided valves.

The source of much trouble is the fracture of seat-

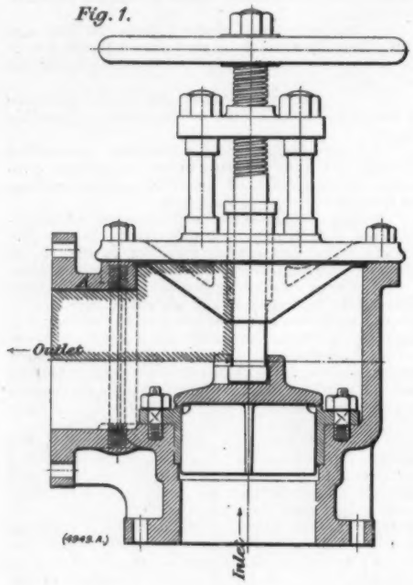


Fig. 1.

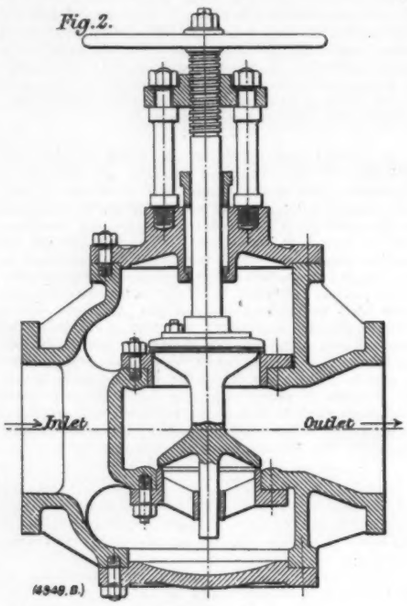


Fig. 2.

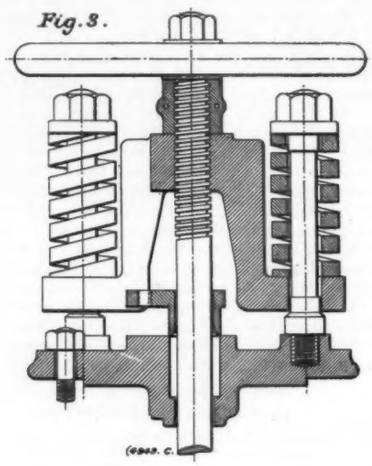


Fig. 3.

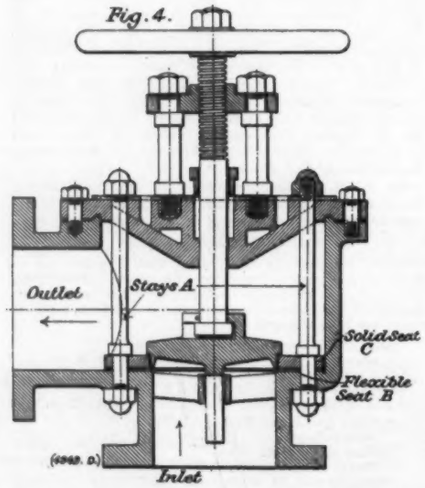


Fig. 4.

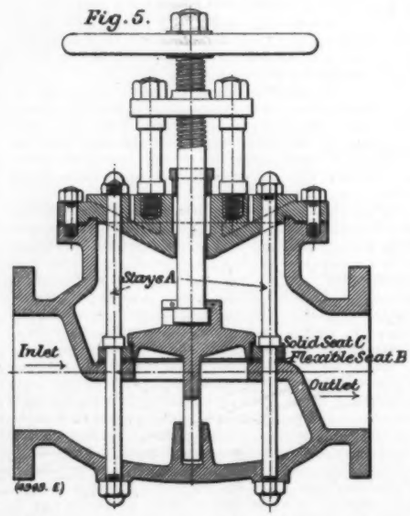


Fig. 5.

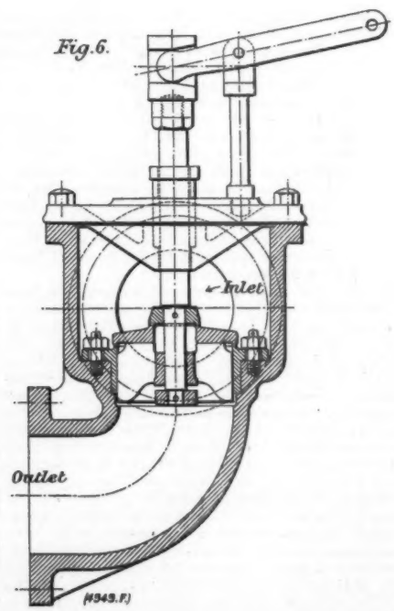


Fig. 6.

* Paper read before the Institute of Marine Engineers, December 12, 1916.

securing pins or studs. In the large sizes it is quite inadmissible to drive the seats in and secure them by means of a pin or pins through the side of the chest and it is absolutely prohibited in all sizes when superheated steam is present, experience showing in this case that seats driven in and secured by side pins become quite slack and allow leakage to occur. The seats in larger sizes are therefore secured in the manner shown in Fig. 1. The only way to avoid serious trouble with this design is to run a wire through the heads of all pins or through split pin holes, if studs are fitted. This prevents the fractured portions being carried to some part where serious damage may be caused.

The question of draining generally cannot receive too much attention, and means should always be provided for efficiently getting rid of all water in both inlet and outlet before a valve is opened.

In Fig. 4 a type of valve is shown which it is suggested is an improvement on that shown in Fig. 1. The first feature that attention is desired to be drawn to is the method employed so that the cover may take up a share of the bursting pressure which acts at right angles to the axis of the spindle. This consists of a tapered spigot on the chest with a corresponding tapered recess in the cover, making a metal to metal joint. The stresses from hardening down and expansion are mainly taken up by the four stays A, which also serve to secure the seatings. With this arrangement no loose parts are situated inside the chest, with the consequent prevention of damage from this source. The valve is centrally guided, thus preventing rotation. A flexible seating is shown at B and when this and the corresponding valve face engage, the solid seat C and its corresponding valve face are $\frac{1}{16}$ in. open, so that when this latter seat and face engage the flexible seating is deflected $\frac{1}{32}$ in. Fig. 5 shows the same design of valve as in Fig. 4, but of straight through or globe type; the design calls for the same attention as in the previous case.

Balanced Valves.—In single-beat valves of sizes over 4 in. and pressures in the region of 180 lb. and above, the valves are difficult to operate unless large diameter handwheels are fitted or handwheel spanners used to give the same effect or gearing introduced. This difficulty is due to frictional resistance in the screw and not to the direct load which, but for that resistance, would allow for quite a reasonably sized handwheel and comparatively quick-pitched thread in valves up to about 12 in. diameter. For regulating purposes large diameter handwheels or gearing are objectionable, not enabling the valve to be handled as expeditiously as is desirable. A compromise for this type of valve is effected and is shown in Fig. 6. A pilot valve is introduced and lifts first, balancing to a certain point the pressure in inlet and outlet branches. The main valve is then lifted against much less load. This fitting is extensively adopted, but occasionally trouble is experienced from the main valve pulsating or clattering, in reciprocating machinery, due to the fluctuating flow of steam—which causes damage to the internal parts. Solid double-beat valves got over this trouble in the majority of cases and were perfectly balanced to all practical purposes, but they had one outstanding defect—they were rarely, if ever, steamtight, which was very unsatisfactory. For reciprocating work this did not affect the steam consumption to any extent, as it was only when the machinery was at a standstill that leakage was occurring, and if a stoppage was of any length of time the boiler stop valves could be shut down. For turbine machinery, however, leaky astern valves can very seriously affect the economy. The leakage in the solid double-beat stop valve was due to differences of expansion between the double-beat valve and the seatings in the chest and could not be got over. A solution of the difficulty was ultimately found in introducing a flexible disc to one of the beats, and the names associated with this introduction were also Messrs. Bevis, Gibson, and Cockburns, Limited. This valve has been very extensively adopted in varying designs and is exclusively used for all regulating valves in His Majesty's Navy.

Fig. 7 shows a double-beat type of valve used for reciprocating work for regulating purposes and also as a throttle valve, doing away with the butterfly type. In this latter capacity a very light duty is thrown on any form of governing gear, while in larger sizes it obviates the necessity for employing a separate throttle engine, say of the Brown type. For ordinary opening and closing as a regulating valve the pin B is locked by the detents as shown, thus allowing the valve to be positively opened or closed. During these operations the control valve is in the neutral position, preventing steam from passing to the condenser. The operating piston has also inlet pressure on both sides of it, thus effecting a balance. The two beats of the valve have saw-formation spigots; this is to allow of close regulation, particularly where shafting is employed to bring the handwheel to a position not directly below the valve. The back-lash in this instance often allows a big jump to occur in the regulation, which is prevented with the design as shown. This jump is due to the following cause: With a valve of this design, that is, with steam entering outside the beats and the spindle going through the cover, there is in the first instance a closing effort due to the pressure on the increase in area of the top beat. The pressure on the area of the spindle where it passes through the stuffing-box is an opening effort. Generally the ratio of the former area to the latter is as two to one, with the result that when the valve is opened to an extent allowing half the initial pressure to be present in the outlet the efforts balance each other. A pound or two over this and an opening effort is present, with the result that the valve jumps open whatever play there is in the operating gear. With the saw formation of spigots this jump does not affect the revolutions to any extent. If instead of the spindle coming through the top of the cover it had come through the bottom of the chest the effort would have been a constant closing one, and there would be no necessity for the provision of the saw formation of spigot. Further on, valves with their spindles coming through the bottom of the chest are shown in Figs. 7*d*, 8, 9 and 10. The saw formation of spigot is a refinement to give close regulation from dead slow to full speed, as many double-beat valves are made without this formation. When the valve is opened to any degree of regulation it can be shut and opened again by the throttle gear in the following manner: In Fig. 7*a*, *b*, *c* the throttle lever B is moved from position 7*a* to 7*c*. The control valve during this operation moves through position 7*b*, holding the main valve open till the detents have cleared themselves from the pin B, then with the throttle lever in position 7*c* the main valve closes—the levers swinging from the nut on the regulating screw. To open up again the lever B is returned to position 7*a*, the main valve opens up and the small tension spring returns the detents, again locking pin B and putting the valve into a position of positive control. This fitting has given general satisfaction and has been extensively adopted.

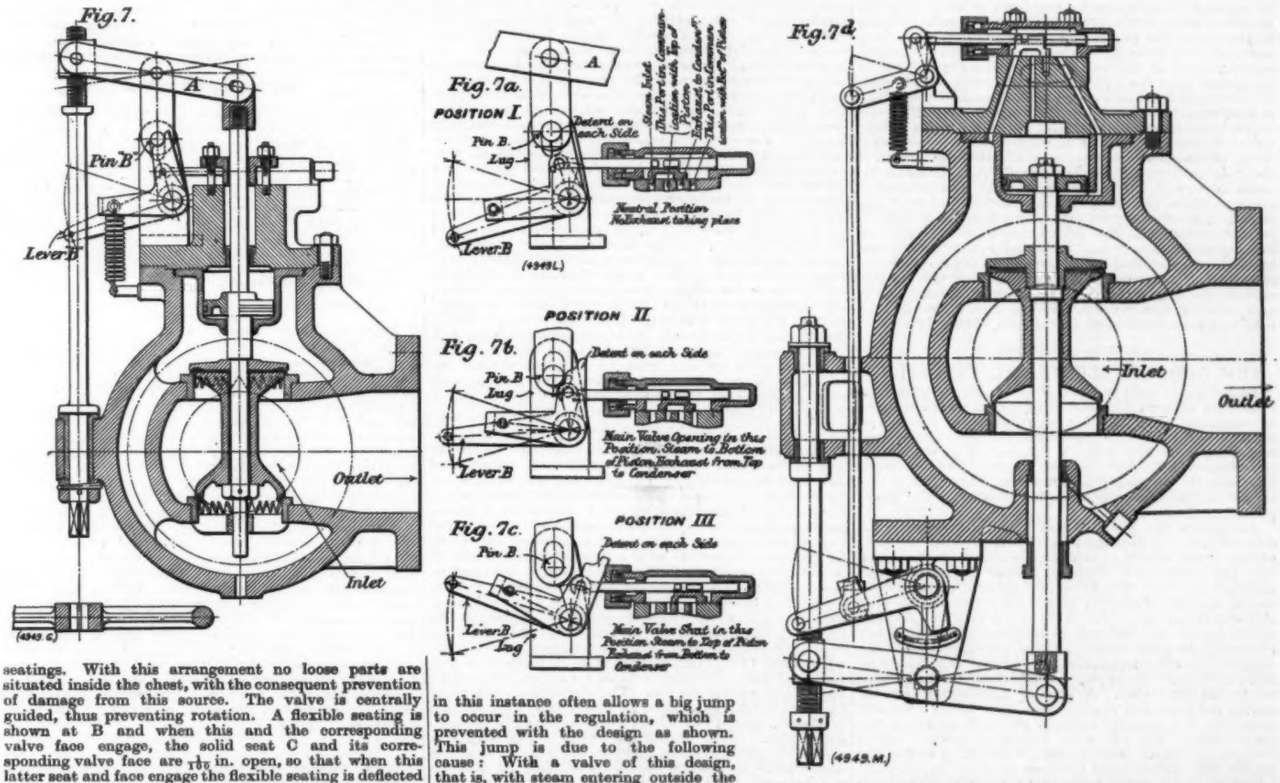
In future it is intended to make the last type of valve as modified and shown in Fig. 7*d*. A constant closing effort is present, which will allow of perfect regulation under all circumstances and will not necessitate the adoption of saw-formation spigots on the beats. The action under throttling conditions is similar to the former valve, with the difference that the slide valve is returned from position 7*c* to positions 7*b* and 7*a* by the spring, assisted by the inlet pressure on the area of the slide-valve spindle where it passes through its stuffing-box.

Hardening-down stresses are alleviated by the expansion of the spindle under temperature. The illustration also shows the relative positions of ports and passages, and consequently gives a better idea of the connection between the positions of the controlling slide valve and the positions of the main valve than is shown in Fig. 7.

To prevent water coming down between the spindle and stuffing-box of the main valve, as far as possible, the stuffing-box is kept high in the inside of the chest, and a drain-hole provided at the top of the packing to drain any water that may tend to accumulate there to the bottom of the chest. Provision is also made for taking away any drips that may come down.

In both the foregoing valves the design has been devised from the point of view that the relative positions of the indexes for both main and throttle valves at the starting platform are exactly similar to those where separate valves are fitted. A point of particular importance has also been carefully observed in the design, namely, that wear and tear have no effect on the efficiency of the gear.

Fig. 8, page 10, shows a type of ahead and astern double-beat regulating valve for turbine machinery, of which a large number have been fitted. With this arrangement one handwheel only is necessary. In a mid position both valves are shut, rotation in one or other direction opens either valve, the shut valve meanwhile becoming the medium of the fulcrum for the opening valve. In a design of this sort it is essential that the handwheel should be most clearly marked by arrows for rotation for ahead and astern. Not only should the handwheel be marked, but an index should be fitted with a pointer of considerable travel indicating quickly which valve is being operated and in what direction. This also applies to single regulating valves because, while in the majority of cases valves are shut by what is termed a clockwise motion, that is right-hand when looking on the handwheel, with the valve or extending spindle receding from the same, there are cases of extended spindles where the motion is clockwise looking in the opposite direction. With the arrangement as shown in Fig. 8 it is possible, if the spindle of the open valve seizes in the neck bush or gland and it is desired to shut this valve and open the other one, that instead of shutting the open valve first the other valve is opened up—a most undesirable effect. To obviate this the design as shown in Fig. 9, page 10, has been adopted, with most satisfactory results. Here the open valve must be positively shut to the point of the spigots entering the seats before the opposite valve can be opened. After this point the valve is closed and contact



made with its seat by the pressure of steam on the difference of area of the two beats of the valve, plus the pressure into the area of the valve spindle where it passes through the stuffing-box. The springs on the spindles also assist this effort. No greater closing effort can be put upon the valve. In this respect it differs from the fitting shown in Fig. 7, where, of course, the valve can be hardened on its seat to any extent.

Another arrangement of balanced valves which has a much greater final closing effort, and consequently ensures tighter valves, is shown in Fig. 10. The valves are balanced by the control valve, which forms part of the spindle, first exhausting steam from the top of the piston. Another outstanding feature is the simplicity of the chest casting, particularly desirable in cast steel. The closing effort when the valves are shut is the pressure on the area of the valves. In these designs of double manœuvring valves and valve as shown in Fig. 7b it will be noticed there are no stresses due to expansion of spindles.

A valve widely adopted in conjunction with turbine machinery for both naval and mercantile work is shown in Figs. 11 and 11a. This fitting is a combined bulkhead shut-off and emergency valve. It also fulfils the function of a self-closing valve in naval work. For ordinary opening and closing the valve is operated in the usual way by means of a handwheel. In the larger sizes it is necessary to employ a handwheel spanner. When the main valve commences to open the collar on it has an inclined plane action on the lever A which lifts the spindle of the non-return valve B, allowing steam to pass to the top of the piston and check any sudden opening tendency. The leakage past the piston rings determines the opening speed of the valve. For shutting by throttle or emergency gear, the lever A is moved further, which opens valve C; this exhausts steam from the under side of the piston, when the pressure on the top of it closes the main valve. On returning the lever the main valve slowly opens up to its previous amount of lift. For naval work, where there are two or more bulkhead valves, if the pipe on the inlet side of one valve is shot away the valve is supposed to self-close with the reverse flow of steam. When this occurs the non-return valve B also closes. The efficiency of this fitting was lately demonstrated unintentionally in a fast ship of war. An exceptionally heavy sea broke over the vessel, the turbines stopped, and for some time no explanation was forthcoming; ultimately it was found that the sea had carried some gear against the deck emergency lever and moved it into the shut position, with the result that both bulkhead emergency valves were effectively shut.

THE GERMAN ELECTRICAL INDUSTRY.

THE reports for the year 1915–16 for the Siemens-Schuckert concern does not show any material changes as compared with those for preceding years. As far as Siemens and Halske are concerned, the profits have been remarkably stationary for a number of years, whilst the Siemens-Schuckert concern shows somewhat larger fluctuations; the dividends, however, have been maintained at the same figure as last year and the years preceding the war.

As regards the Siemens and Halske Company, production has not decreased as compared with the preceding year, although the requirements of the army and the navy have wrought several changes in the different sections. The net profits amount to 12,503,549 marks, against 12,538,327 marks for the preceding year and 12,511,197 marks for 1912–13. A sum of 1,500,000 marks goes to the war welfare institution. Siemensstadt (against 3,000,000 marks for the previous year), the capital of this institution, to which the Siemens-Schuckert concern has also contributed, now amounting to 10,000,000 marks. A sum of 2,000,000 marks, as during the preceding year, is specially reserved; 900,000 marks go to a gratuity fund for the staff, as during the year before; and the same applies to 500,000 marks to a reserve fund. The company's capital is 63,000,000 marks, and the dividend has been fixed at 12 per cent., which dividend, except for 1913–14, has been maintained since the year 1908–9 inclusive.

The Siemens-Schuckert concern states that the demand for electric machinery could not be fully met, since the production of substitute substances for electrical lines and their insulation, in which work the company had been heavily engaged, took up a considerable time. The methods of production had to be adapted to the new materials, and they themselves had to be fully tested in actual working. Export to countries overseas had been entirely stopped on account of the English blockade. The company's works were largely engaged in the production of war material for the army and the navy; the increased industrial demands, especially from the chemical and the heavy iron industries, had brought about an extreme degree of employment in the electric motor branch. The available capital had materially increased during the year, but the transition to peace work would no doubt draw heavily on the funds. The working profits were 25,500,000 marks, against 27,988,987 marks for the preceding year, the dividend, as during the former year, being fixed at 10 per cent., the share capital being 90,000,000 marks. A sum of 2,500,000 marks, as the year before, had been added to the reserve, gratuities to staff and hands again absorbed 1,500,000 marks, 500,000 marks were again added to a reserve fund, and 1,500,000 marks went to the Siemensstadt Institution, against 4,000,000 marks the year before. The net profits amounted to 15,310,326 marks, against 17,775,473 marks for the previous year, the highest figure before the war being that of 1912–13, when the net profits amounted to 13,847,970 marks.

It would appear that neither company, judging by their respective balance sheets, has done quite so well during 1915–16 as during 1914–15, but the difference does not amount to much, and there may be invisible reserves which more than make up for the difference.

The Rhenish Schuckert Company for electrical industry, at Mannheim, like the other large concerns, shows no difference to speak of between 1915–16 and 1914–15, the gross profits being respectively 2,530,138 marks and 2,522,906 marks, and the net profits 910,952 marks and 902,077 marks; the dividend is 5 per cent., as for the previous year. The share capital is 11,000,000 marks. The sale of electric energy showed an improvement.

THE GERMAN STEEL UNION.

A QUESTION which has for some time past occupied the attention of the German Steel Union is as to how the required quantities of products of the Union can be secured for meeting both the direct and the indirect army demands. The obtaining of sufficient quantities of half-finished products and sections is surrounded with special difficulties. The reason for this is to be found in the price policy adopted by the Steel Union at the instance of Government. On account of Government interference the Union is not in a position further to raise the selling price of the products which it controls. As a result, the works no longer trouble the Union with requests for orders. On the other hand, the State insists upon the large steel works, which do not themselves manufacture certain specialities, supplying the works that do manufacture them with the requisite half-finished products. Therefore if the works belonging to the Union do not distribute among themselves the manufacture of Union products in sufficient quantities, it may be expected that the State will intervene and take the necessary coercive measures—measures which the works have the keenest interest in preventing. Negotiations which have been going on within the Steel Union in this connection have led to a proposal, which will be laid before the next meeting of the Union. The object of the proposal, by a rise in prices for half-finished goods, sections and railway material, is to create an inducement for the works to undertake the supply of such goods. It is proposed that the difference in price be made good to the Union in the shape of subsidies paid by those works which use their own steel production almost exclusively for war purposes, and thereby earn larger profits than if they partly disposed of their steel production in the shape of half-finished products through the medium of the Steel Union. It is further proposed that all the works within the Union are to supply Union products in the tabulated quantities, in accordance with their allotment figures. The works are then to obtain a higher price for any quantity supplied beyond the tabulated figure, whilst the works lagging behind with their deliveries of Union products will have to pay a fee to the Union for every ton short-delivered.

GASOLINE-CRACKING FURNACE.—In our issue of August 18, 1916, on page 158 of our last volume, we described the cracking process which has been worked out by Dr. Rittman, in conjunction with Messrs. Dean, Dunn, Dutton, Egloff and others, at the U. S. Bureau of Mines, and has been tried on a commercial scale in conjunction with the Aetna Explosives Company, of New York. In Technical Paper 161 of the Bureau of Mines, Mr. P. Bowie gives some further account of the construction and operation of a single-tube Rittman cracking furnace for making gasoline. The paper is fully illustrated, and thus instructive for those especially interested in the process. The furnace, 17 ft. 1 in. high by 6 ft. 3 in. wide, gave satisfaction in those dimensions; steel tubes, lap-welded, 13 ft. 2½ in. long, 13 or 14 in. inside diameter, answered best; they were provided with top and bottom flanges and with a tar pot. The stirrer was made from an extra strong 3-in. pipe, to which four vertical rows of chains, each 10 in. long, were fastened by through cotter pins. Great precaution, owing to fire risks, was needed in taking samples from the tar pot and from the condenser; the outlets should be at least 50 ft. from the furnace. The removal of the cover of the tube, which remains full of inflammable gas for hours after shutting down the furnace, also requires the greatest care; the gases should be driven out by dry steam, not wet steam. Accidents have evidently occurred.

WAR ECONOMIES IN LIGHTING AND STREET ACCIDENTS.—Addressing the Illuminating Engineering Society on recent progress at the opening of their new session in December, Mr. L. Gaster, the honorary secretary of the society, also commented upon the very unscientific way in which the darkening of the streets was effected. Many lamps in shops and streets were burning at full intensity, but most of their light was wasted because almost the entire surface of the globe was darkened. The patchiness of the light, the contrasts between dark and darkness, the want of method in the arrangements, which differed in different districts, and the absence of light on foggy evenings, were very undesirable features. Gas and electric supply companies were tied by their contracts, and neither they nor the borough councils were inclined to embark upon rearrangements of the lighting systems, which might afterwards be vetoed. Meanwhile street accidents by motor vehicles of all kinds had increased at an alarming rate, in spite of several factors which ought to diminish accidents, as the following figures (taken from Parliamentary returns) of fatal accidents and non-fatal accidents—proved :—

	Fatal.	Non-fatal.
1913	424	13,153
1914	493	14,638
1915	666	16,366
1916 (to October 31) ...	509	11,827

NOTES FROM THE UNITED STATES.

PHILADELPHIA, December 13.

BASIC iron is quoted to-day in northern markets at 35 dols. The possibility of a famine is leading many large concerns to anticipate their requirements for still more remote periods. The United States Steel Corporation has now on its books orders for 11,058,542 tons, as against 7,189,489 tons a year ago, and against 3,324,592 tons two years ago. Much of the present booked business runs over into 1918. Norway is in the market for 72,000 tons of plates, for delivery over five years, beginning the second half of next year. It is improbable that this order will be accepted in the shape it is presented. The same country has ordered 22 Baldwin locomotives. The Santa Fé Co. has ordered 30. The advances last week outside of pig-iron relate to minor products, such as iron and steel pipe, spikes and sheets, the latter advancing 5 dols. per ton. During the past two months general prices have advanced 10 dols. per ton. Railroads are covering railroad requirements for 1918, and Chicago mills are getting most of the business. In one day last week 1,250,000 tons of rails were sold for 1918. Much bridge work is also coming in. The pressure for ship plates continues beyond all precedence. Contracts are being placed from two to five years ahead. During November 75,000 tons of wire were ordered for export. A rough estimate of contracts now on the books for steel billets shows somewhere between 3,000,000 and 4,000,000 tons. Sales of pig-iron since December 1 foot up 250,000 tons, of which 60,000 tons are for Italy, France and Canada. Additional orders for pig-iron are in sight and furnace stocks are practically exhausted.

HÉROULT STEEL FURNACES IN AMERICA.—We read in *The Iron Age* that licences have been granted by the United States Steel Corporation for the installation of two Héroult electric steel furnaces as follows: Atlas Crucible Steel Company, Dunkirk, N.Y., a 3-ton furnace for the manufacture of tool steel. Crucible Steel Company of America, Harrison, N.J., a 3-ton furnace for the production of alloy steels; this is in addition to a 6-ton Héroult furnace which has been operating for some time. These two contracts bring to 82 the number of Héroult furnaces contracted for or operating in the United States and Canada.

ATTENDANCE AT GERMAN HIGH SCHOOLS, SUMMER, 1916.—The number of students matriculated at German high schools of various descriptions totalled about 71,000 last summer. This figure included about 5,700 women and 2,000 foreigners. The 22 universities of the Empire had 56,900 students, including 5,640 women, on their rolls; the 11 technical high schools had 10,200 students (100 women); the 6 commercial high schools (at Berlin, Cologne, Leipzig, Munich, Mannheim, Königsberg) had 12,000 students; the 2 veterinary high schools (at Berlin and Hanover) had 600 students; the 3 agricultural high schools (at Berlin, Hohenheim, Weihenstephan) had 500 students; and the 3 mining academies (at Berlin, Clausthal, Freiberg) had 400 students; the 4 academies of forestry remained closed. These figures are nominal, however. For of the 71,000 students only 20,600 were actually in attendance, and this figure comprises the women and foreigners, so that only 13,000 male German subjects were actually studying; the rest, representing 88 per cent. (81 per cent. in summer, 1915) were on military duty. Even these numbers have to be further reduced; several thousands of these students were discharged soldiers, still on the matriculation rolls, or soldiers on leave. Thus the number of students not in the forces was very small, and some of those attending lectures were, moreover, liable to be called up.

WAR PROFITS IN GERMANY.—The Gutehoffnungs Hütte Company for Mining and Iron Industry, which belongs to the Haniel family concern, has probably beaten the records in the way of war profits, the net profits amounting to 24,168,816 marks, or about 80 per cent. of the share capital, against 5,911,000 marks for the preceding year and 7,590,819 marks for 1913–14, the turnover being 168,011,291 marks, against 95,854,141 marks for the year 1914–15. The company's production in tons for the last three years was as under :—

	1915-16. Tons.	1914-15. Tons.	1913-14. Tons.
Coal	3,278,324	2,941,930	3,843,711
Coke	680,927	714,370	856,511
Iron ore	419,144	327,940	605,904
Pig-iron	597,015	508,094	814,074
Rolled goods ..	498,518	406,430	627,650
Other products ..	123,552	66,064	108,795
Wire and wire products, Gelsenkirchen	42,155	36,940	81,656

The gross profits for last year amounted to 43,372,849 marks, against 16,314,692 marks for the preceding year and 20,603,642 marks for 1913–14. The writings-off amount to 10,214,129 marks, or close upon 50 per cent. more than during the two preceding years. The dividend of 20 per cent., against 15 per cent. for 1914–15 and 10 per cent. for 1913–14, absorbs but one-fourth of the net profits; no less than 17,320,000 marks are reserved for various funds, against 650,000 marks and 1,075,000 marks respectively for the two preceding years. The liquid assets have increased by about 40,000,000 marks, whilst items on the debit side have only risen by about half that amount.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Sulphate of Ammonia.—During the past year the production of sulphate of ammonia has been well maintained, while its home consumption has very materially increased, both as a fertiliser and as a necessity in the manufacture of munitions. For this latter purpose the demand has developed most extensively, and towards the end of the year the price steadied up, with the result that from 18*l.* 10*s.* to 19*l.* per ton has been paid for prompt delivery.

Scotch Steel Trade.—In order to permit of the few days' cessation of work, the closing days of the week were days of ceaseless activity, so that the repairing squads might be in no way hampered in what they had to do. In the West of Scotland generally the past year must stand out as one of unprecedented industry under conditions of a most abnormal description, nor is there the slightest possibility of these conditions being in any way relaxed so long as the war continues, while the chances are that they may be further stiffened, both during and after the war, as the unavoidable wastage must be made good. Works closed down on Saturday for the brief and well-earned New Year holiday conceded by the Ministry of Munitions, and in most cases a start will be made again to-morrow (Thursday) morning, although in some instances where the necessary repairs, &c., have been more extensive, the respite from labour will be prolonged until Monday. When work is resumed the demands of our own and the Allied Governments will probably be much increased, as every description of war material will be in great request. Prices were unchanged when work stopped on Saturday.

Malleable Iron Trade.—Malleable iron makers continue to report the greatest pressure in all their departments, the difficulty of delivering both raw and finished material being a very present drawback. The hope is expressed, however, that the curtailment of the passenger train service will place increased means of transport at the service of manufacturers, and particularly of those engaged on war work. Order books are well filled, and the prospects for the future are brighter than perhaps ever before. During the past year makers have had to face the serious problem of shortage of skilled labour, but it is interesting to note that where the services of women have been requisitioned these have given the utmost satisfaction. No change in the price of "Crown" bars has taken place, the quotation still standing at about 14*l.* 10*s.* to 14*l.* 15*s.* per ton.

Scotch Pig-iron Trade.—Although it is scarcely possible for the works to be closed and the furnaces damped down at this time, so far as practicable the holidays will be observed and a few days' respite be permitted to such numbers of the workers as can be conveniently spared. Every facility must be given to the repairing squads, so that no time may be lost, for there is much alteration and repair required to furnaces and machinery and only a very short time in which to do it. While the holiday feeling is responsible for a certain slowing-down, little appreciable change falls to be noted; matters move along as they have done for a considerable period now, the demand for all grades of pig-iron, and notably for hematite, continuing as strong as ever. Excepting for the use of the Allies, no pig-iron is being exported, while it is very evident that supplies will only be available for the direct purposes of the war.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—With holiday-making general few traders have attended 'change this week, and business has been almost suspended, but great confidence is expressed in the future, and expansion of transactions is anticipated as pig-iron production is increased, by the steady restarting of plant that has been idle for some time past. Values are well upheld. For home consumption No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge all stand at 87*s.* 6*d.*, and No. 1 is 91*s.* 6*d.*; whilst for despatch to our Allies No. 3 is 98*s.*; No. 4 foundry, 96*s.* 6*d.*; No. 4 forge, 95*s.* 6*d.*; and No. 1, 102*s.* 6*d.*; and for shipment to neutral countries the minimum rates named are 105*s.* for No. 3 and 110*s.* for No. 1. Scandinavian and other customers abroad are quite prepared to pay 105*s.* for No. 3.

Hematite Iron.—So far as can be ascertained there are no new features in the East Coast hematite branch of trade. Here, as in Cleveland, further increase of output is assured, and consequently a growing volume of trade is looked for. The price of Nos. 1, 2 and 3 for home use stands at 122*s.* 6*d.*, for shipment to France the figure is 137*s.* 6*d.*, and for export to Italy the quotation is 124*s.* 6*d.*

Stock.—The stock of Cleveland pig-iron in the public warrant stores has been reduced to 3,738 tons, consisting of 3,702 tons of No. 3 and 36 tons of other kinds of iron deliverable as standard. During December the stock was reduced by the withdrawal of 435 tons of No. 3. There are now warrants in circulation for only 2,500 tons.

Coke.—Local demand for coke is less insistent than it has been, but requirements continue heavy, and values are well maintained. Average blast-furnace kinds remain at 28*s.* at the ovens, and 30*s.* 6*d.* at the ovens is still named for qualities low in phosphorus.

Foreign Ore.—Imports of foreign ore to the port of Middlesbrough for the first three days of the new year total no less than 25,055 tons.

Manufactured Iron and Steel.—There is little new to report concerning the various branches of the finished iron and steel industries. Holidays have enabled many firms to effect much-needed repairs and renewals to plant. Manufacturers have very full order-books, and prices all round are strong. Acceleration in shipbuilding is responsible for considerable new development. The following are among the principal quotations to home customers: common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 19*l.* to 20*l.*; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel strip, 17*l.*; steel hoops, 17*l* 10*s.*; heavy steel rails, 10*l.* 17*s.* 6*d.*; iron and steel packing iron (parallel), 12*l.*; and iron and steel packing iron (tapered), 14*l.* 5*s.*

Iron and Steel Shipments.—Shipments of iron and steel from the port of Middlesbrough last month totalled 51,719 tons, 35,909 tons being pig-iron, 2,924 tons manufactured iron, and 12,886 tons steel. Clearances of pig for the previous month were returned at 31,656 tons, and for December a year ago the loadings of pig reached 56,716 tons. Of the pig-iron despatched in the last month of 1916, 35,324 tons went to foreign ports and 585 tons to coastwise customers; of the manufactured iron shipped 746 tons went foreign and 2,178 tons coastwise; and of the steel cleared 12,878 tons went foreign and 8 tons coastwise. The largest customer was France, despatches to that country being given at 28,949 tons of pig-iron, 510 tons of manufactured iron, and 11,852 tons of steel. Other importers of pig-iron were the United States of America, 4,000 tons; Italy, 1,600 tons; Japan, 765 tons; and India, 20 tons. Japan received 171 tons of manufactured iron and India 56 tons. India took 342 tons of steel; Japan, 220 tons; China, 206 tons; and Hong Kong, 201 tons.

Record Wages at Consett.—The average net selling price of steel plates made at Consett during September, October and November last has just been certified as such as gives under sliding-scale arrangements an increase in steel millmen's wages of 5 per cent. in the current quarter commencing January 1, which raises wages to 60 per cent. above the standard. Never before have wages at Consett touched such a figure, the previous highest being 27½ per cent. above the basis at the end of December, 1900. Just prior to the war wages were 15 per cent above the standard, and in the third quarter of 1914 they were reduced by 2½ per cent. In April, 1915, there was an increase of 2½ per cent., and from then to the present time the rate has advanced by 47½ per cent.

New and Extending Works.—The Tees Conservancy Commission report the total area of land at present reclaimed from the foreshore of the River Tees is about 3,230 acres. The reclaimed land for sale on the north shore of the Tees is 1,140 acres—less 322 acres sold to the Ecclesiastical Commissioners for England and the Central Zinc Company, Ltd., also an area of 83 acres sold to Messrs. Wm. Gray and Co., Ltd., of West Hartlepool, for the construction of dry docks, shipbuilding yard, &c., and 68 acres at Portrock recently purchased by the South Durham Steel and Iron Company, Ltd., Stockton-on-Tees, in view of large extensions.

BAVARIAN NITROGEN WORKS.—The Bayerischen Stickstoff-Werke, A.-G., of Munich, raised their capital from 4,000,000 to 12,000,000 marks during the past year. The clear profits, deducting war tax and special funds, of the last two years amounted to 1,145,600 marks, and dividends of 14 and 12 per cent. were declared in 1916 and 1915. The demand for Kalkstickstoff (nitrolim) was growing; the price was fixed at 1.47 marks maximum, per kilogramme of available nitrogen, which is a little higher than the peace price, but considerably lower than that of other nitrogen manures.

INDUSTRIAL COMBINE IN SWEDEN.—In Sweden several amalgamations have lately taken place, and an important move has just been recorded. The large and ably-managed General Swedish Electric Company (Almänna Svenska Elektriska Aktiebolaget) in Vesteras, has purchased a controlling interest in the shares of the Swedish Turbine Company, Ljungström, and in the Surahammar works. The Surahammar works holds a leading position in Sweden as regards railway material, and this speciality, as well as others, will be pushed with all energy, at the same time as other lines particularly adapted for the General Electric Company will be taken in hand and extended. The Ljungström Turbine Company controls the Ljungström patents for Sweden, Norway, Denmark, Finland and Russia. A branch factory will in all likelihood soon be erected in Russia, so as to meet the great demand in that country. The other Ljungström patents are owned by a separate company, with which the General Swedish Electric Company has arranged an intimate co-operation, so far, however, without buying any shares in it. The General Swedish Electric Company is, in consequence of the transactions, increasing its capital from 1,170,000*l.* to 1,500,000*l.* The Ljungström Steam Turbine Company has a share capital of 335,000*l.*, of which the General Electric Company has purchased 222,000*l.*, having likewise acquired two-thirds of the Surahammor Company's share capital of 295,000*l.* The General Electric Company has done exceedingly well during the war, increasing its turnover for the first half of 1916 by some 60 per cent., compared with the corresponding period of the previous year, and the share capital has during the war been increased from 670,000*l.* to 1,170,000*l.*

NOTES FROM THE SOUTH-WEST.

Cardiff.—Business continues to be dull in the Cardiff coal trade; the last prices to reach us are as follow, best Admiralty steam coal remaining nominal, as heretofore:—Second steam coal is quoted 29*s.* to 30*s.*; Black Veins, 29*s.* to 30*s.*; Western Valleys, 29*s.* to 30*s.*; best Eastern Valleys, 27*s.* to 30*s.*; best bunker small steam coal has made 19*s.* to 20*s.*; and cargo smalls, 12*s.* to 18*s.* In bituminous coal, best households have made, at the pit head, 25*s.* 6*d.* to 26*s.* 6*d.*; seconds, 23*s.* 6*d.* to 24*s.* 6*d.*; No. 3 Rhondda large, 28*s.* to 30*s.*; No. 2 Rhondda large, 27*s.* to 28*s.*; and bituminous smalls, 21*s.* to 22*s.*; the four latter quotations being f.o.b. prices. Special foundry coke has been quoted 62*s.* 6*d.* to 67*s.* 6*d.* and furnace coke 47*s.* 6*d.* to 52*s.* 6*d.*; patent fuel has made 35*s.* to 37*s.*; these three quotations being for export; and pitwood, ex ship, 51*s.* to 52*s.*

Western Trade Matters.—The third annual meeting of the Glamorgan Wagon Company, Limited, was held at Imperial-buildings, Cardiff Docks. Mr. Henry G. Lewis (chairman of the directors), who presided, said that the result of the past year had proved satisfactory, and he was glad to point to the continued progress of the company. A dividend for the year of 6 per cent. was agreed to, and Mr. Henry G. Lewis was re-elected a director.—Mr. R. H. Mungall, who has been associated since January, 1909, with Messrs. D. M. Stevenson & Co., coal exporters, Cardiff, Glasgow, Newcastle and Hull, has now ceased to be a partner in the firm. The business will be carried on as hitherto by the remaining partners, Sir D. M. Stevenson, Mr. Allan M. Wilson and Mr. W. Lindsay Carlow.—The annual meeting of the Griffiths-Lewis Steam Navigation Company, Limited, was held on December 29, at Cardiff. Mr. E. T. Griffiths presided, and stated that the company had lost two steamers during the year, leading to a serious loss in trading profit owing to a lack in earning power. Profit amounted in round figures to 55,865*l.*, and the dividend for the year was placed at 20 per cent., free of income-tax.—The death occurred on December 30 of Mr. John Roberts, J.P., mining engineer. He was general mining manager for Messrs. Cory, Yeo and Co., Swansea, and agent for the Ashburnham, Berrington and Sir John Llewelyn's mining properties. Mr. Roberts had given evidence as an expert before numerous commissions; he had a complete knowledge of the Welsh coalfields.—It is stated that upon the suggestion made by Lord Rhondda, President of the Local Government Board, the colliery companies with which he was formerly connected will, in order to encourage the cultivation of land, plough up with the aid of colliery horses some hundreds of acres. This will give the men an opportunity to plant it with potatoes. The scheme is greatly appreciated. The expense of ploughing up the land will be borne by the collieries.

PARIS INDUSTRIAL FAIR.—H.M. Vice-Consul in Paris notifies that the Paris Industrial Fair for 1917 will be held in the Tuileries Gardens from May 1 to 15 next. The fair will be confined to French and French Colonial manufactures.

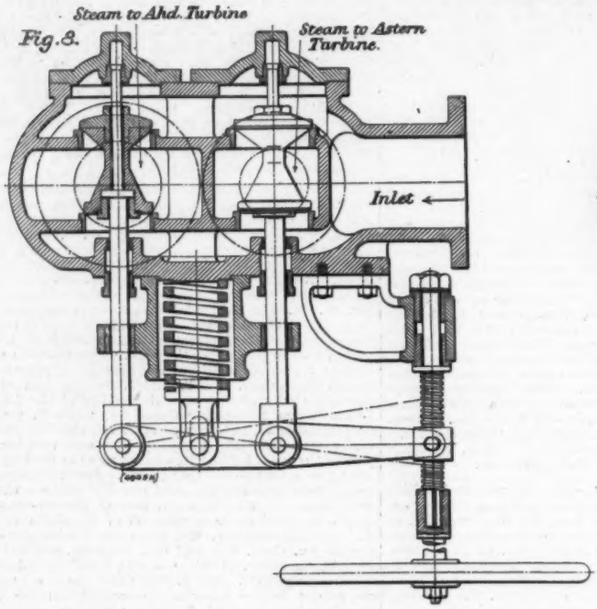
STEEL SCRAP.—We read in *The Iron Trade Review*, Cleveland, Ohio, of December 14, that great activity in scrap, particularly heavy melting steel scrap, has been a feature of the market during the past week. In Cleveland, in one day, sales of heavy melting steel, at 27 to 27.50 dols., amounted to 1,000,000 dols., and, later, sales of this grade were made at nearly 30 dols. In the Philadelphia district the Pennsylvania railroad obtained the highest price in its history for its steel scrap, being paid 25 to 30 dols. per ton. In Pittsburg 10,000 tons were sold at 27 dols., some dealers asking 30 dols. per ton.

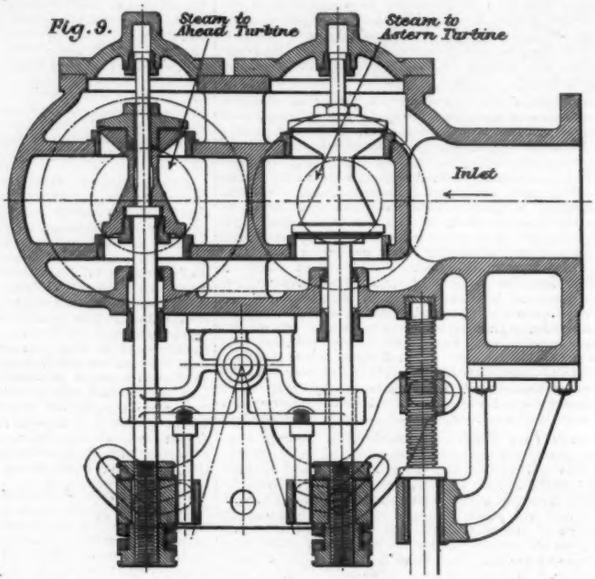
THE PRUSSIAN CROWN PURCHASE OF COAL MINES.—The Prussian Diet, whilst in principle acquiescing in the purchase of the shares in the large Hibernia coal mine concern, was fairly free with its criticism of the details of the measure. Nearly all the speakers found the price to be paid too high, and the Minister admitted that it was by no means profitable. This, it has been stated, seems to be an accepted rule at such Crown purchases. When the State buys a private undertaking it has to pay not only the full price of the day, but it has also to recoup the vendor for possible future gains and chances which he forfeits by the sale. This is the only way in which such deals can be brought about voluntarily. The State has, in consequence, to seek its remuneration or profit in future uncapitalised chances and in financial and State-industrial considerations.

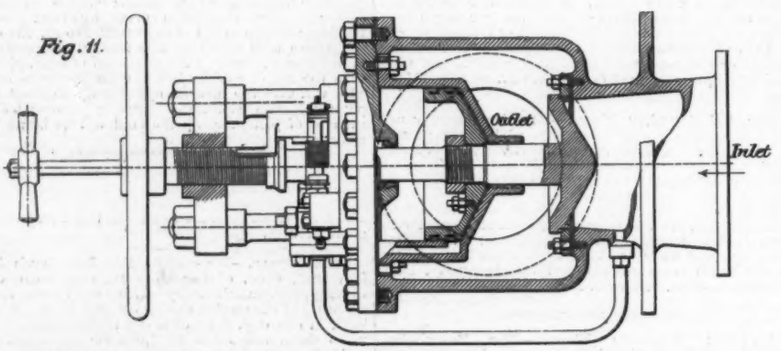
UNITED STATES EXPORTS AND SHIPBUILDING.—It is stated in *Commercial America*, Philadelphia, that of the American mercandise shipped across the seas in the first nine months of 1916, over 450,000,000 dols.' worth was carried under the American flag and 3,000,000,000 dols.' worth under foreign flags. Compared with the same period a year ago these were increases of 76 per cent. in the case of American shipping and 50 per cent. in the case of foreign shipping. In other words, while but a very small proportion of the export trade of the United States is carried in American vessels, the proportion of that trade so carried is showing a very much higher rate of increase than that carried in foreign ships. One of the most important factors entering into this changing condition, says the American journal, is the steady increase in the number and tonnage of the mercantile fleet of the United States. The reports of the individual shipyards as submitted to the Bureau of Navigation show that the steel merchant vessels building, or under contract to be built, in private American shipyards on October 1 numbered 417 for 1,454,270 gross tons.

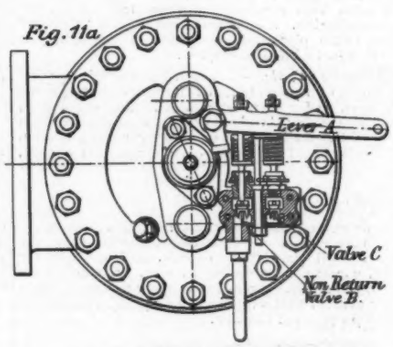
HIGH-PRESSURE STEAM STOP VALVES.

(For Description, see Page 6.)





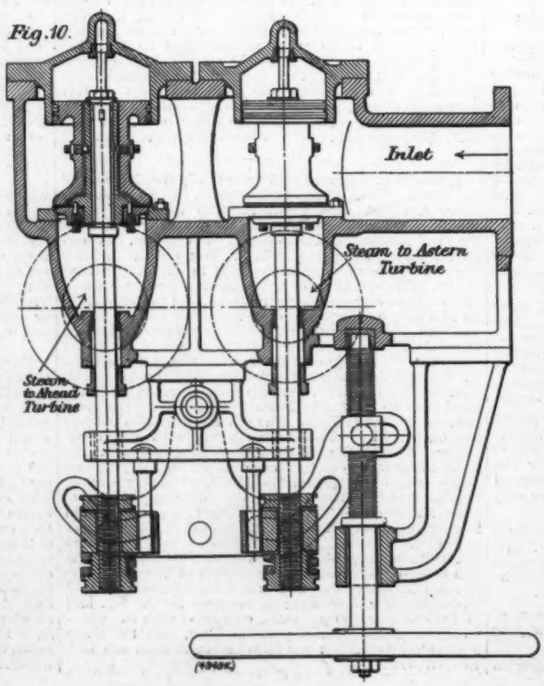




ELECTRIC VEHICLES.—As a result of correspondence between the Electric Vehicle Committee and the Ministry of Munitions, a tentative arrangement has been agreed to by the latter under which the firms at present manufacturing electric vehicles in this country will be allowed, for the time being, to manufacture such vehicles for purposes of urgent national importance.

DEVELOPMENT OF AMERICAN CHEMICAL INDUSTRIES.—The Second National Exhibition of American Chemical Industries, held in New York last September, was visited by 70,000 people, and gave proof of a remarkable development. At the beginning of 1914 six works manufactured artificial dyes from European intermediate products, and only one small works in the United States supplied aniline. At present 18 firms manufacture carbolic acid, more than 40 works supply aniline, and more than 30 works supply tar colours. The export of chemicals, drugs, dyes and medicines from the United States were officially estimated at 24,000,000 dols. in 1914; the figure had risen to 46,000,000 dols. in 1915, and the exports of the past year, 1916, were estimated to come up to 125,000,000 dols. It seems to be forgotten over here too often that the after-war competition will not entirely come from the Continent.

FERRO-CONCRETE VESSELS.—We read in the *Anglo-Norwegian Trade Journal* that the Aktieselskapet Fougners Staal-Beton Skibsbygnings Kompagni, of Moss, which specialises in the construction of ferro-concrete vessels, has just completed its eighth 100-ton barge. The success which has attended this departure from shipbuilding methods has caused the promoters to contemplate extending their sphere of action, and there is every probability of a branch of the business being established in the United Kingdom at the end of the war. The orders at present in hand include a 2,000-ton barge, a 3,000-ton twin-screw motor lighter, and several floating docks. Mr. Alf Bryde, managing director of the A/S Maritim, has placed an order with Messrs. Fougners Staal-Beton Company for a floating dry dock to be built of ferro-concrete. The dimensions of the dock will be 80 ft. by 25 ft. inside measurements; it will be able to dock vessels or lighters up to 12 ft. draught. The dock is to be finished by April 1, 1917.



RESTRICTIONS ON THE USE OF COPPER.—The Ministry of Munitions announce that from January 1, 1917, no copper will be supplied for the purpose of casing brass or other copper alloy, and no brass or other copper alloy may be cast except for the purposes of Class "A" or Class "B" orders, under the Ministry of Munitions Circular L. 33.

HIGH-SPEED ENCLOSED MOTORS.—For many purposes totally enclosed electric motors have considerable advantages, as they can be used in places where an open motor would be liable to suffer severely from grit or be capable, as in flour mills and ammunition works, of igniting the dust in the air and thus producing a perhaps serious explosion. In other cases motors have to work in damp situations, and here, again, enclosed motors have considerable advantages. Against these have, however, to be offset the difficulty of securing a reasonable output from a given weight of motor or of volume occupied. All the heat generated in the iron and windings has ultimately to be removed by the outer air, and if this be excluded from the actual working parts, as it is in the case of enclosed motors, special arrangements for cooling are necessary. In an arrangement now being put on the market by Electromotors, Limited, of Louisa-street, Openshaw, Manchester, a simple form of air-cooled radiator is fitted to the motor, and through this the air enclosed in the casing is regularly circulated by means of a fan fitted to the motor shaft. The efficiency of this arrangement is, the makers state, so high that they can, without using excessively large radiators, supply enclosed motors running at high speeds and having nearly the same capacity as a ventilated motor of same frame size,

THE WOOLWORTH BUILDING, NEW YORK.

(*For Description, see Page* 1.)

FIG. 1. VIEW OF LOWER NEW YORK, SHOWING THE WOOLWORTH BUILDING ON THE LEFT.

FIG. 2. THE WOOLWORTH BUILDING, SHOWING SIDE-WALK PROTECTION DURING ERECTION.

(*To face page* 2.)

THE WOOLWORTH BUILDING, NEW YORK.

(*For Description, see Page* 1.)

FIG. 3. VIEW OF SITE, JULY 19, 1911, SHOWING WORKING PLATFORM AT STREET LEVEL.

FIG. 4. VIEW OF SITE, SEPTEMBER 25, 1911, SHOWING SINKING OF FOUNDATION CAISSONS.

THE WOOLWORTH BUILDING, NEW YORK.

(*For Description, see Page* 1.)

FIG. 5. THE MAIN ENTRANCE.

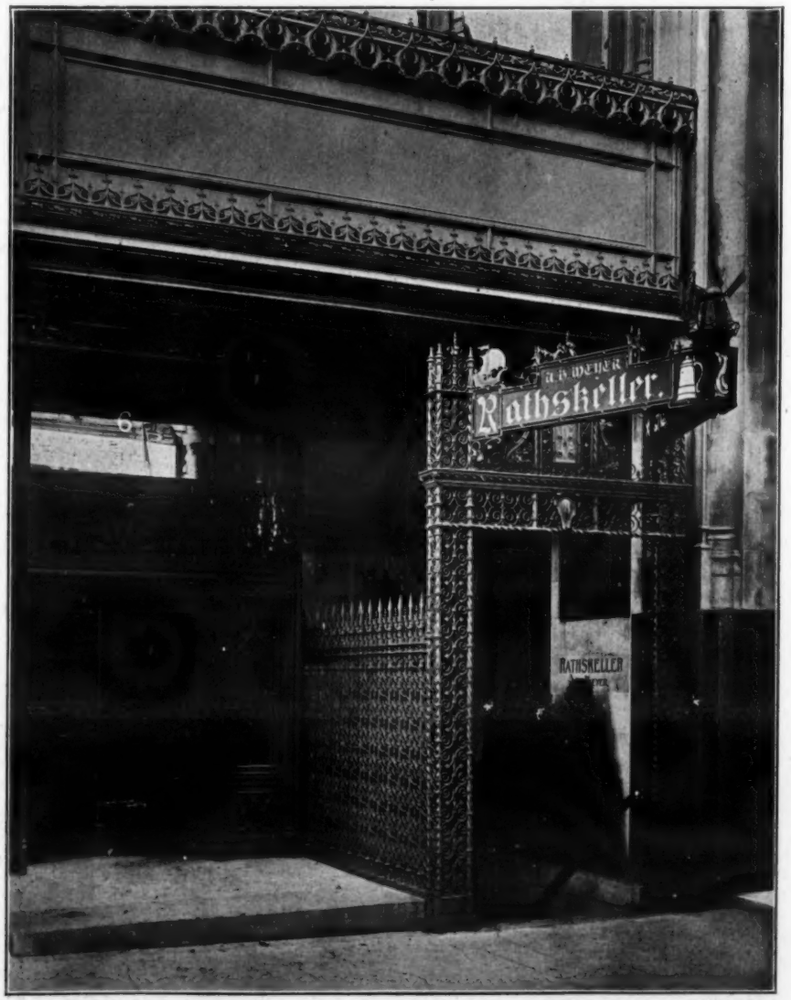


FIG. 6. THE MAIN CORRIDOR.

HIGH-SPEED BORING, MILLING AND DRILLING MACHINES.

CONSTRUCTED BY MESSRS. GEORGE RICHARDS AND COMPANY, LIMITED, BROADHEATH, MANCHESTER.

(*For Description, see Page* 19.)

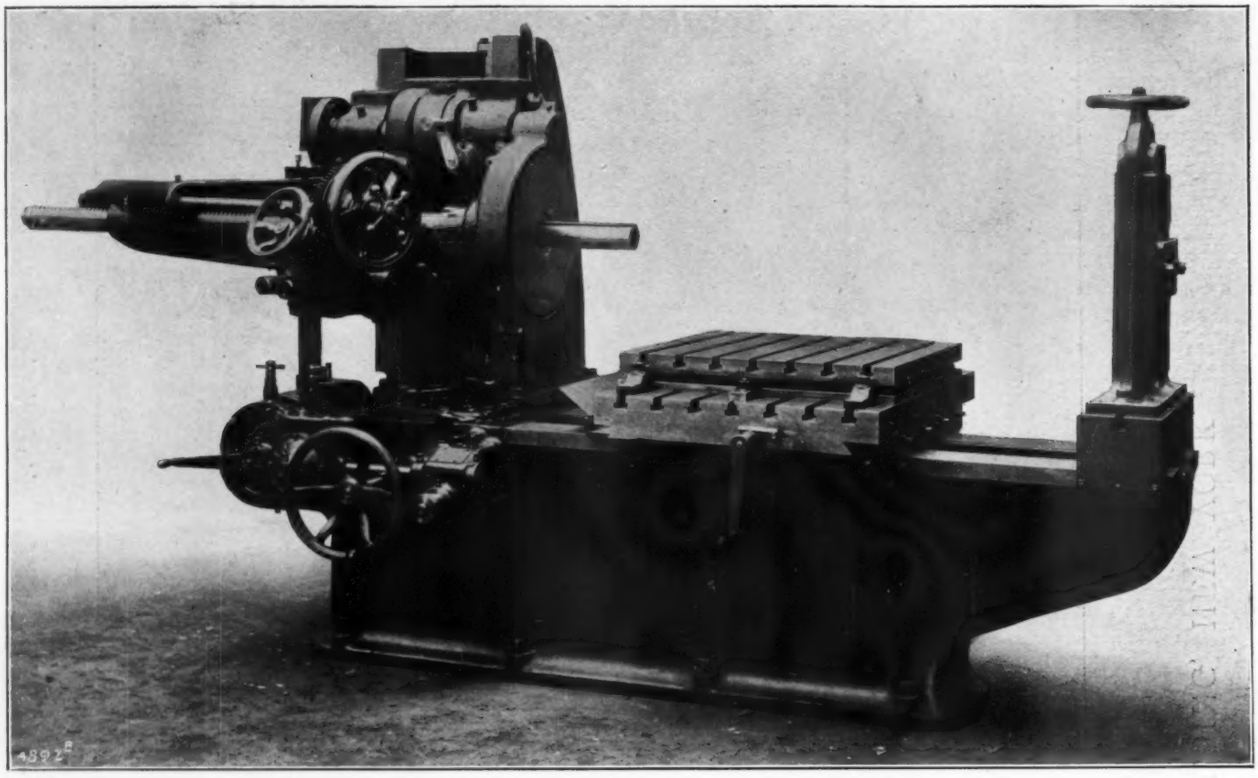


FIG. 1. HIGH-SPEED BORING, MILLING AND DRILLING MACHINE.

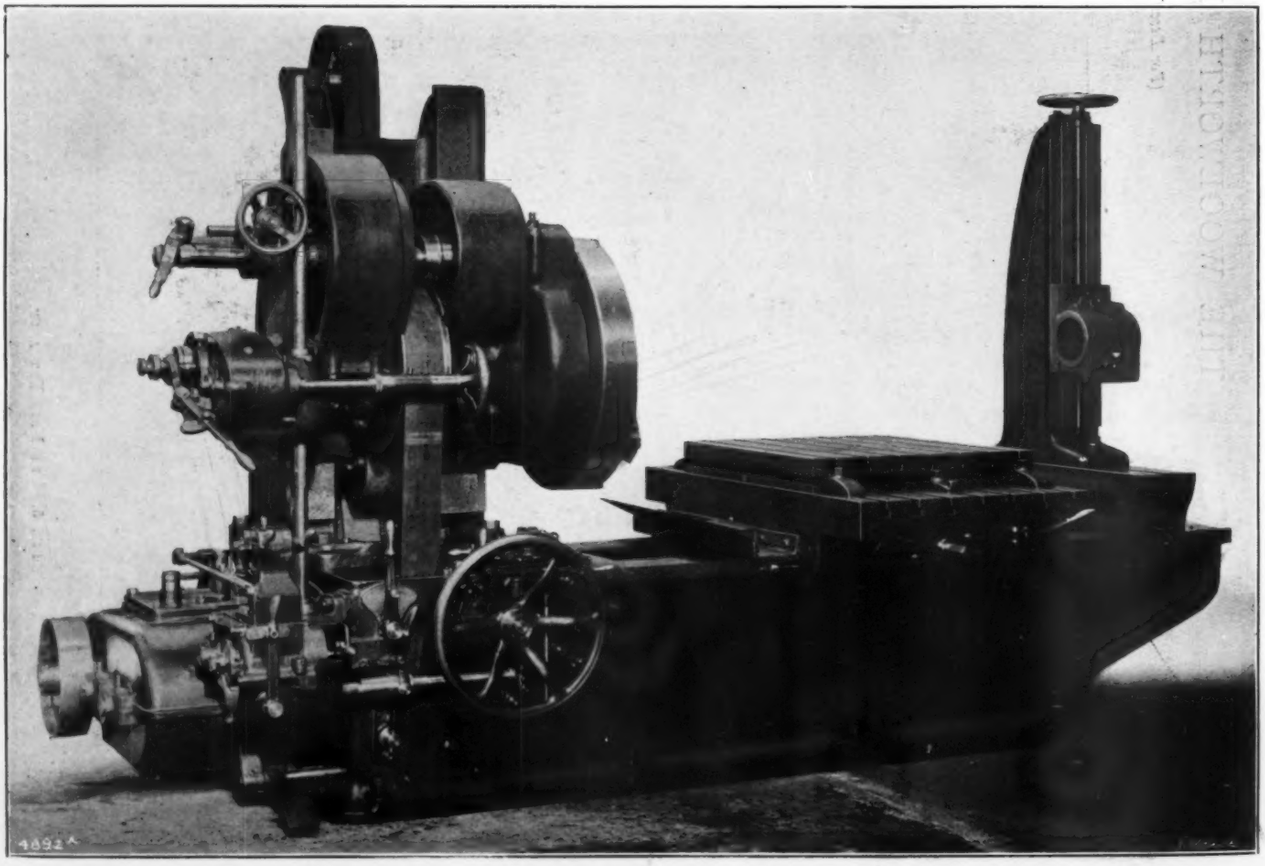


FIG. 2. THE PEARN-RICHARDS COMBINED SURFACING, BORING, MILLING, DRILLING AND TAPPING MACHINE.

(*To face page* 3.)

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ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any Newsagent in town or country and at railway book-stalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

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The increase in the annual subscription is entirely due to the new postage rates on newspapers.

For Canada—			
Thin paper copies	£1	11	6 ($7.65)
Thick "	£1	16	0 ($8.75)
For all other places abroad—			
Thin paper copies	£1	16	0
Thick "	£2	0	0

When foreign subscriptions are sent by Post-Office Orders, advice should be sent to the Publisher.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C.

Offices for Publication and Advertisements, 35 and 36, Bedford-street, Strand, London, W.C.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3683 and 8593 GERRARD.

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With Three One-Page Plates of the WOOLWORTH BUILDING, NEW YORK, and One One-Page Plate of HIGH-SPEED BORING, MILLING AND DRILLING MACHINES.

NOTICES OF MEETINGS.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS: LONDON SECTION.—Monday, January 8, at 6 p.m., at the Institution of Electrical Engineers, when a paper will be read by Mr. H. H. Harrison, on "The Story of the Keyboard Perforator."

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 9, at 5.30 p.m. Paper to be submitted for discussion: "Recent Progress in Dredging Machinery," by Mr. William Brown, M.Inst.C.E. And ballot for new members.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH LOCAL SECTION.—Tuesday, January 9, at 7 p.m., at the Princes Street Station Hotel, Edinburgh. Paper: "Principles Involved in Computing the Depreciation of Plant."

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Wednesday, January 10, at 8 p.m., in the Hall of the Royal Society of Arts, John Street, Adelphi, W.C., when Colonel R. E. Crompton, C.B., R.E., will read a paper entitled "Notes on Screw Gauges."

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, January 10, at 8 p.m., at St. Bride's Institute, Bride Lane, Fleet Street, E.C. A paper will be read by Mr. A. Alban H. Scott, M.S.A., on "The Design and Construction of Industrial Premises." Mr. Frank Bailey, M.Inst.C.E., President, in the chair.

THE INSTITUTION OF ELECTRICAL ENGINEERS: YORKSHIRE LOCAL SECTION.—Wednesday, January 10, at 7 p.m., at the Philosophical Hall, Leeds. Paper by Mr. F. Gill and Mr. W. W. Cook, "Principles Involved in Computing the Depreciation of Plant."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 11, at 8 p.m. "The Principles Involved in Computing the Depreciation of Plant," by Mr. F. Gill, Member, and Mr. W. W. Cook, Member.

THE OPTICAL SOCIETY.—Thursday, January 11, from 5 p.m. to 9.30 p.m. An exhibition of workshop methods of optical testing will be held at King's College, Strand.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

MARRIAGE.

McCormack–Desmond.—(By Special License) Brian Hugh, only Son of Arthur McCormack, The Dell, Middleton Hall Road, King's Norton, to Eileen, third Daughter of Albert Desmond, 289, Hagley Road, Edgbaston, Birmingham.

ENGINEERING.

FRIDAY, JANUARY 5, 1917.

REFLECTIONS ON EFFORT AND SACRIFICE.

THE beginning of the year has ever been a season for reflection. At present there is increased inclination and greater need for this. And the result brings fuller hope than in the recent past, even in peace times. This is not due to any failure to recognise fully the tremendous stress of the ordeal through which we have yet to pass. It is consequent, rather, upon a fuller realisation of the situation and of the necessities of the case, and a stiffened determination to face the facts. The exchange of "peace" notes among the Powers has clarified the air from the international standpoint. It has afforded another opportunity for a clear enunciation of the issues which must be settled before there can be peace of any degree of permanency. It has dispelled the fog of detail which tends to obscure the great work for humanity which we have undertaken. The national duty is thus once more brought home to all, and hope is born from the fact that we begin the year more fully organised as a nation than at any previous epoch in our history, and are more ready to make sacrifices individually for the common cause.

Our national organisation is the result of lessons learned amid sorrows and anxieties due to past inefficiencies and indecisions. These disabilities have long existed; they have long dogged our footsteps. Our progress, despite them, has been wonderful, but retarded. They have been accentuated during war because of the terrible nature of the consequences. We have now done much to remove them so far as immediate requirements go; but we cannot too often plead for reflection on the question as to whether there should not be action now to ensure that as far as is reasonably possible the organisation of national efficiency should apply equally to peace as to war conditions. No doubt the limit placed on the duration of all restrictions of liberty—"for the period of the war"—and the proviso that in cases of concessions there is to be a return to the *status quo ante bellum* are accentuated to comfort those making concessions. But every effort should be made so to educate all that they will be able to realise that where advantage accrues there should be a continuance of the conditions proved to be beneficial. Necessity has now done more to establish the wisdom of economic principles than all the teaching of the past, and it would be well that it should be brought home to the people that the effect follows cause, apart altogether from the incidence of the law of necessity.

Never before have the working classes had such high earnings per week. That is a condition which greatly assists, if it is not essential to, national prosperity. Earnings represent work efficiently done. The production represents national wealth, and during war or peace wealth production is of universal benefit. High earnings or efficient work is achieved by collective and individual superiority. There has been during the past two years a great awakening to the need for both and a considerable approach to its attainment. More is promised under the organisations now devised by Government departments; but these can only achieve their fullest results by the disinterested co-operation of all, and particularly of employer and worker. As has been repeatedly shown, the most pressing war problem of the moment is the supply of shipping. It affects the import of raw material for munitions of all kinds, and the food question, with its influence on the cost of living, as well as the transport of men and material to the fighting line. The Controller of Shipping has acted wisely in the appointment of a committee of shipbuilders to ensure efficiency of work from what we have termed the collective standpoint, and he is to be congratulated, too, in the choice, as chairman, of so active and forceful as well as so experienced a shipbuilder as Mr. George Carter. The work of the committee should not only be beneficial now but give a valuable lead for peace time.

In the past there has been too great a tendency in some establishments to unlimited variety of work. Efficiency does not lie along such lines. Concentration alike in mental and mechanical effort yields the best result. In the former case there will be immediate and general acquiescence. As to the latter, there must be waste of time in adapting machine tools from time to time to the variety in form or size of the work to be done, unless there is such multiplication of tools as shall conform to each job, and this involves excessive capital expenditure, with the possibility of insufficient continuity of work to ensure return on the capital. The same applies to the worker. A man accustomed, say, to the building of destroyers, is apt to be over-exacting when engaged on cargo-ship building, and unnecessary precision and unwarranted cost results. In the opposite case there is danger of the standard of excellence set not being reached. This example might be multiplied. Where, as is sometimes the case, production is confined to a given type, there is gain in the time occupied as well as in the cost of the work done. It will, therefore, be one of the first duties of Mr. Carter's committee to arrange merchant shipbuilding work in such yards as are available for it, so that these conditions will yield the greatest good to the nation. It will require experience in organisation; it may involve hardship for the owners of works; it will certainly demand a large measure of self-denying patriotism. Shipbuilders, like all employers, have, however, in the past two and a half years acted with singleness of purpose—to advance the national cause—and no difficulty will be experienced on this count. We hope, as we believe, that far-reaching and permanent gain will result from this special organisation.

But what of the workers? Here we write with less of certainty. Full fruition of our hopes requires individual as well as collective effort. There is less of sacrifice on their part. The *clientèle* is not affected as with the employers. The week's earnings may, probably will, remain high. It cannot be too often enforced that high earnings are conducive to prosperity and economy. But just as each establishment now and in the future must be confined in respect of product to that which it is most suited efficiently and rapidly to construct, so each machine tool and each worker must be apportioned to the operation where the best result can be got. The only preferences must be dictated by fitness. To

employ a skilled man on unskilled work is a waste of man-power, just as it would be a waste of mechanism to use a 12,000-ton press to forge a 2-in. bolt. Prosperity and economy require not only high earnings to the worker, but as cheap production in the interest of the buyer as is possible. Thus the best and speediest machine tool must be utilised to its fullest capacity by a worker giving forth no more mental or physical effort than are requisite. The capacity of the machine when augmented enables the earnings to be increased while reducing the cost of work by adding to the volume. This has been the universal experience during war times when trade-union restrictions have been waived. This is the real reason why men and women have had high earnings. That fact should be forced home time and again. What has been done with shells, fuze-making, gun-building, howitzer-carriage construction, applies with equal benefit to the worker in all departments of engineering activity. Mr. Carter's committee have also the benefits of the dilution methods instituted by the Ministry of Munitions to assist them in the acceleration of merchant shipbuilding, so that there is prospect of success with great advantage now and in the future in speeding up work.

There is much that is hopeful. The lessons cannot all fall in all cases on deaf ears. The idea of equality of reward irrespective of great variations in talent and effort is subversive of progress in every respect. The reward must be measured by some standard, and we trust that employers in the future will err rather on the side of liberality than otherwise. The spirit of trustfulness by workers must be cultivated. They must be encouraged to believe that the great part of the benefit resulting from increased effort in production will continuously accrue to them. We commend to our readers the views put forward by Mr. J. R. Richmond on the claims of labour in his presidential address at the Glasgow University Engineering Society, reproduced on page 20. His remarks afford food for reflection alike by employer and worker; and, as we said at the outset, there is need and encouragement for reflection under the stress of the present and the anxiety for the future.

FORCED LUBRICATION FOR MARINE TURBINES.

WITH the more or less general adoption of geared turbines to all classes of ocean-going vessels, in most of which, unlike the navy, there are only two engineers on watch, it has become necessary to give the subject of lubrication considerable thought with a view to obtaining a degree of simplicity and dependability which will reduce attention and anxiety to a minimum.

When considering the adoption of any particular system, it must be borne in mind that no hitch should be possible which might in any way make it necessary to stop the turbines, otherwise, under difficult sea conditions, results might be disastrous. To meet such a condition, all important fittings which in themselves could obstruct the passage of oil must be supplied in duplicate, or be capable of being by-passed and be easy of rapid overhaul.

As every trade route has its own conditions to meet, it is impossible to describe a system suitable for every class of ship, but it is proposed to describe a system which will meet the requirements of many single-screw cargo-carrying vessels, and which can be modified to meet special conditions, arising from long voyages, tropical waters, &c.

A combined gravity and forced system offers the greatest advantages, and consists simply of a pump taking oil from a drain tank and discharging it through a cooler to a gravity tank, from which it falls to the turbine bearings, &c., and back to the drain tank. Or can be by-passed, in which case it does not enter the gravity tank, but is forced direct to the machinery.

The following main fittings would be required for such a system, and are stated in the order in which the oil would pass through them, when travelling from the drain tank to the turbines:—One drain tank; two oil strainers (one for each pump); two pumps (one working and one stand-by); one oil cooler; two gravity tanks; and one combined oil distributor and water and sludge collector. There are many small fittings of a more or less essential character, and these will be dealt with in describing the above main fittings.

The drain tank should be of sufficient capacity, when full, to supply oil for fifteen minutes, assuming none is returning to the drain tank, or, in other words, the oil should be travelling four complete circuits in an hour. The tank should be a self-contained unit placed in a cofferdam in the double bottom rather than built into, and forming part of, the double bottom, and should be easy of removal for examination. The top should be not less than 6 in. below bottom of the gear case to ensure a ready drain, and not less than 3 in. above double-bottom tank, to clear bilge water. In addition to the drain and suction pipe connections, a float level indicator must be fitted so as to be easily observed from the starting platform, also an air pipe and manhole.

The oil strainers perform an important duty and deserve attention in design. The body may be of cast-iron, having a cover easy of removal, to enable inspection and cleaning of the straining grid. The grid may be a gunmetal casting or a steel tube perforated with holes, say 1 in. diameter, and in either case the area through grid should be about 10 times that of suction pipe. A suitable straining medium will be found in 24-mesh wire gauze, this to be properly secured to the grid. The gauze will reduce the effective area through grid by about half. The strainer should be in an accessible position, and have the cover on top to avoid overflow of oil when cleaning.

The pumps are made by specialists and need no particular description; however, they should be ordered of ample capacity and be fitted with a valve or cock on discharge, and suction branches for isolation purposes in case of overhaul at sea. For guidance purposes the speed of oil through discharge pipes may be taken at 200 ft. per minute for pipes 3 in. diameter and above.

The oil cooler calls for special attention, particularly when the vessel passes through tropical waters. It may take the same form as a steam condenser, with similar tubes and packing, but with the water circulating around outside of tubes, with preferably a four or six flow to ensure good circulation. This plan has been largely adopted, but it is economically impossible to render the flow of the oil turbulent, and the rate of heat transfer is accordingly low. Even viscous fluids, however, will not maintain the laminar character of the flow around a sharp corner. Hence certain firms construct their coolers in a different way. The water is passed through the tubes and the oil outside. Numerous baffles are fitted to cause the oil to flow up and down in zigzag fashion across the cooling tubes, and at each abrupt change of direction a certain disturbance is produced in the laminar flow of the oil which facilitates the interchange of heat. At present knowledge of oil coolers is in its infancy, and there is much room for research and careful design. It is desirable to fit thermometer pockets on oil and water inlet and outlet. The present practice admits of oil discharging to turbines at 80 deg. F., and leaving turbines at a maximum of 120 deg. F. The cooler should be easily accessible and have a by-pass fitted.

Each gravity tank should be of equal capacity to the drain tank and be fitted with cocks to enable either tank to be in circulating use while the other acts as a settling tank. These tanks must be placed high enough to give a gravity pressure of at least 10 lb. per square inch, and should be fitted with gauge glass and float indicator with wire leads and gauge board arranged to enable the level to be observed from the starting platform. A manhole, air pipe and overflow pipe must be fitted, the overflow pipe being led back to the drain tank or reserve oil tanks. As previously mentioned, a by-pass is fitted between the pump and the gravity tank to enable forced lubrication to be applied to the turbines without the oil having to pass through the gravity tanks.

The combined oil lubricator and water and sludge collector need be nothing more than a cylindrical casting of sufficient depth to admit of water and sludge gathering at the bottom, while oil flows out at the top to the bearings and gear sprayers. It is desirable to fit separate connections from the distributor to the bearings and gear sprayers, with a controlling valve at each, as an adjustment is thereby easily effected whereby the bearings and sprayers will each receive their proper share of oil. A water draw-off cock placed about 12 in. from the bottom and a door for removal of sludge are to be provided.

Having covered the main fittings, a word or two on the turbine fittings might not be out of place. Control valves on each turbine bearing are unnecessary, provided the pipe arrangements are such that all bearings get an equal chance. To ensure this, pipes should have easy bends and branches on pieces be given direction with flow of oil. Means of testing the flow to bearings must be provided, and may take the form of a sight glass placed in the line of pipe, or of a test cock on the high-pressure side of a bearing, having a visible flow to the drain side. As an extra precaution pressure gauges may be fitted on the pressure side. The gearing sprayers should each be fitted with a guard cock having a locked-open arrangement.

The pipes and fittings should be tested to 50 lb. per square inch, with the exception of the tanks, for which a 5-lb. test is sufficient. A relief valve should be provided near the pump set to blow-off at 50 lb. per square inch, having an outlet led to the pump suction. The pipes may be of steam-quality iron, with the exception of the small sizes, where it will be found cheaper and more convenient to fit copper pipes with nipples. Great care should be taken in shops to clean out turbine, gear case and other castings thoroughly. A steam jet will be found a convenient means of removing all traces of sand and other foreign matter, while linen makes a good finishing-off cloth. Cotton or other waste should not be used, as much trouble has sometimes arisen due to the strands of thread, &c., left on the castings. It is impossible to lay too much stress on the importance of this necessity for thorough cleaning.

It will be noted that nothing has been said regarding the water circulation to the oil cooler; this can be arranged as desired, but a separate pump is undoubtedly best, with a stand-by connection from main condenser circulating pump. If this latter is fitted, a good circulation is obtained by leading the discharge from the cooler to the main circulating pump suction. Should a separate overboard valve be fitted, it must not be placed higher on the ship's side than the main circulating discharge, otherwise the heads are unequal and the cooler might suffer accordingly.

The system described is a simple one, with as few complications as possible, and can be adapted to most vessels. It has been pointed out in some quarters that particles of metal from the gearing mix with the oil and gradually work their way into the bearings, with bad effect. To avoid this, separate systems have been fitted, one to the turbine bearings, and the other to the sprayers and gearing bearings, it being necessary to combine the two latter, due to the drain being a common one into the gear case. It is very doubtful if such a partial correction is worth all the duplication of working parts necessary to carry it out, and it is also doubtful if with good quality of gearing and reasonable changes of oil any trouble may be expected from the bearings.

GASOLINE EXPLOSIONS IN SEWERS.

Two explosions, disastrous to property though, fortunately, not to life, occurred a few years ago in a big sewer of the city of Pittsburg. The 8-ft. sewer drains one portion of the city which contains more automobile garages than any other district, and the explosions were ascribed to leakages of gasoline and other inflammable fluids from garages, cleaning establishments, &c., into the sewer. An investigation conducted by Messrs. G. A. Burrell and H. T. Boyd on behalf of the Bureau of Mines seems to establish that the sewer air could only become explosive by the introduction of unusually large quantities of gasoline; but it also shows that leakage of gasoline may lead to explosions in mine entries, tunnels, &c. The experiments are described in Technical Paper 117 of the Bureau of Mines.

The sewer selected for the experiment is 8 ft. 6 in. high and has a width of 8 ft. 3 in. The sewer drains into the Allegheny River, and there are six manholes on the selected section of 2,706 ft. length. To determine, in the first instance, the velocity of the

fluid passing down the sewer, pine floats 6 in. square were dropped into manhole 1 at a given signal, and observers stationed at the other manholes watched the passage of these floats. The average velocity found was 6.45 ft. per second; speeds of about 5 ft. were observed on other days; the depth of flow was about 8 in., the grade of the sewer being 0.9 per cent. The experiments were made in October and November, 1914, when the temperature distribution was mostly very uniform; that is to say, there was, *e.g.*, on one day less than 1 deg. C. difference in the temperature of the air and that of the water in the sewer and the air above the water, all the temperatures being about 20 deg. C. Gasoline was introduced into the sewer in several ways to be described, and samples of the sewer air were collected in two ways, and analysed by Mr. M. S. Evans. The tips of evacuated glass bottles were broken by knocking them against the walls of the sewer, so that the air rushed into the bottle, or, preferably, pumps were placed near the manholes and joined each to a bottle from which a piece of hose was hanging down into the sewer; air and vapours could thus be withdrawn from definite levels, generally 2 in., or 2 ft. above the water-level in the sewer.

In the first series of tests a 55-gallon barrel of refinery gasoline (54 per cent. of which boiled below 110 deg. C.) was dumped, all at once, into manhole 1 of the sewer and air samples were collected at intervals between 2.10 and 4.45 p.m., previous analyses having demonstrated that there was no gasoline vapour in that sewer. At ordinary temperature and pressure 1 gallon of gasoline would give about 32 cub. ft. of a gasoline vapour nearly three times as heavy as air. The sewage flow would carry the gasoline rapidly down the sewer, and as only 1.46 per cent. of the gasoline in question boiled below 40 deg. C., not much gasoline would evaporate from the surface of water at 20 deg. C. Two minutes after the introduction of the gasoline the air from manhole 2 (553 ft. below manhole 1) contained 0.87 per cent. of gasoline vapour, and 3 minutes after the introduction air from manhole 3 (482 ft. further below) contained 2.19 per cent. of gasoline vapour. This latter vapour percentage was the maximum observed, and within 10 minutes it had dropped to 0.23 per cent.; the lower limit of explosibility of the gasoline-air mixtures would be about 1.5 per cent. of gasoline. The figures from the further manholes were much lower, and it resulted that the emptying of 55 gallons of gasoline into a big sewer at fairly rapid flow would create explosive conditions only for a few minutes; the vapours scarcely spread upward, moreover.

During this first series of experiments the manhole covers had been removed. In the second series the covers were left on and a 55-gallon barrel was emptied at the rate of 5 gallons per minute, the whole operation requiring 11 minutes; the sewer temperature was 20 deg., the air temperature 24 deg. C. Again it was ascertained that any particular spot rapidly cleared itself of vapours. At a height of 2 ft. above the water-level the vapour percentage never exceeded 0.70; at 2 in. above the surface it rose to 1.14 at manhole 2 within 13 minutes of the feed period, but only a trace of vapour was left 5 minutes later. The maximum percentage of 1.67 was found at manhole 3 6½ minutes after the feed period. At manhole 4 (1,670 ft. from manhole 1) the clearing of the air took longer, 1.1 and 0.12 per cent. of vapour being found within 16 and 31 minutes of stopping the feed. During the gradual introduction of the gasoline the conditions were certainly explosive; within 15 minutes afterwards a sheet of flame would probably have swept down the sewer; but the danger would soon have passed.

In the third series of experiments the water in the Allegheny River was high and the sewer outlet was submerged. Under such conditions the air in the sewer would have more time to become impregnated with vapours. In order to create suitable conditions, a bulkhead was built at manhole 3, and the sewage flow was diverted, by means of sandbags, into another sewer near by; the water in the sewer was afterwards allowed to back up gradually. Gasoline was emptied into manhole 2, again at the rate of 5 gallons per minute, and observations were taken between 11.40 a.m. and 3.30 p.m. Extremely dangerous conditions were found, as had been expected, between manholes 5 and 6, even 5 hours after running in the gasoline. In a fourth series only half a barrel was emptied, instead of a full barrel, and conditions were found, on the whole, to be proportionately less dangerous; it was also observed that the vapours did not travel up-stream by more than a few feet.

Finally, observations were made, in conjunction with the city inspector, in the sewer in which the explosions mentioned in the introduction of this article had occurred. The grade of this 8-ft. sewer is 0.97 per cent.; the depth of flow varies from 12 in. up to the entire cross-section. Four men were stationed along the sewer to collect samples every half-hour, or at shorter intervals if necessary. In this way, 6,533 tests were conducted in the course of a year, the conditions being the ordinary conditions of the district, in which a good deal of gasoline leakage into the sewer may always take place, as we stated. Yet, in 6,278 cases (95.8 per cent. of the total number) the gasoline vapours did not exceed 0.05 per cent.; only in 10 tests values above 0.4 and up to 0.7 per cent. were observed. It would thus appear that the conditions which had led to the explosions must have been very unusual. At the same time the investigation teaches a lesson. What is a harmless contamination of the sewers with regular flow may become a source of danger for hours if any obstruction should favour the local accumulation of explosive vapours.

THE FRENCH COMMERCIAL PORTS AND THE WAR.

SINCE the war was forced upon the world practically the whole of the industrial establishments throughout France, whatever may have been their manufactures before hostilities broke out, have been commandeered by the State for supplying the military needs of the nation and part of the needs of the allied armies. One direct consequence is that little labour has been available to any extent for what we may term "commercial exports." But notwithstanding this latter fact, the French ports during the past two years have been called upon to deal with an exceedingly large amount of traffic, so large, indeed, that in some instances important work has had to be carried out rapidly in order to enable them to cope with the influx as satisfactorily as circumstances would permit. Since the war broke out the traffic has been, so to speak, one of imports only, and it includes coal, motor cars, meat, corn and a thousand other items required by the country in general and by the armies in the field.

French economists have long acknowledged that most of the French ports were insufficiently equipped for dealing adequately with the country's commercial peace requirements; the ports frequently became congested, and large programmes had been prepared for meeting the situation. The work these covered had been commenced in a few ports, but operations had proceeded in a dilatory way and had, of a necessity, to be suspended entirely as soon as war broke out, owing to the immediate call to the Colours of the men employed.

Taking the whole of the traffic, there is not much difference between the total figure for 1914 and that for 1913. The animation at the ports—traffic being hardly the term to use in this connection—increased with 1915, and the increase has also been marked in the course of the present year, by reason of the development in the needs of the nation and of the extent of the call made upon the outside world to meet those needs, not only in regard to munitions and material of war, but also in regard to stores and provisions of all kinds.

The decrease in the normal commerce of France is shown by the fact that during the year 1915 the total weight of French exports fell to less than a third of the total weight for the year 1914, five months of which were taken up by the war.

Taking several French ports separately, it is found that the total traffic—both imports and exports—through Calais in 1913 was 1,170,000 tons; the figure fell to 746,000 tons in 1914 and rose to 1,177,000 tons in 1915, owing to the large increase in imports. The total traffic in Boulogne was 1,273,000 tons in 1913, 879,000 tons in 1914, and 1,372,000 tons in 1915, also owing to the large increase in imports. The figures for Dieppe were 598,000 tons, 548,000 tons and 849,000 tons; those for Havre were, in 1913, 3,501,000 tons, 3,191,000 tons in 1914, and 4,942,000 tons in 1915. The figures for St. Nazaire were 1,730,000 tons in 1913 and 2,326,000 tons in 1915. The rise had not been so marked in regard either to Bordeaux and Marseilles. The above figures are given merely as rough indications, since several ports do not include in their statistics the operations effected for account of the British and Belgian armies, and these have been and are still, as is well known, considerable in their extent.

An idea of the fall in French exports is afforded by the following figures, taken among many:—From 1913 to 1915 the weight of goods exported from Calais fell from 118,000 to 25,000 tons; the corresponding totals for Boulogne were 148,000 and 56,000 tons; for Dieppe, 124,000 and 55,000 tons; for Havre, 910,000 and 419,000 tons; for St. Nazaire, 252,000 and 82,000 tons; for Nantes, 353,000 and 148,000 tons; for Bordeaux, 1,191,000 and 1,021,000 tons; and for Marseilles, 3,052,000 and 2,357,000 tons. But against these figures showing the decrease in the French exports have to be placed others showing the considerable increase in the weight of imports of raw material, coal and other items of primary necessity. Thus the import of coal through Dieppe increased by about 100 per cent. in the period under consideration; the coal imports through Rouen, which in 1913 amounted to 2,827,000 tons, exceeded 6,000,000 tons in 1915.

In order to meet this increase in the imports, especially in the case of certain goods which require special care and treatment in their forwarding, important works have had to be improvised and carried out; it was necessary to extend many unloading platforms and to improve and increase in power and speed the installations for handling and lifting the goods. As instances of the work carried out in this respect, we may mention that a new wooden quay, 650 ft. in length, has been built at Bordeaux, a second one, double that length, has been built farther down stream, and the port of Blaye, nearer the entrance to the River Gironde, has been enlarged; similar wooden quay installations have been put down at Tonnay-Charente, near Rochefort, at St. Nazaire, Nantes, Havre, Rouen, &c. Berthing accommodation has been increased on the rivers, where the incoming ships are unloaded, when practicable, by floating cranes which deliver into barges, these latter being then towed up the rivers and canals for the distribution of goods throughout the country. Railway sidings have been laid alongside the new quays. These and excellence in organisation have enabled phenomenal work to be done in connection with the immense war importations, especially during the past twelve months.

NOTE.

THE RIFLING OF DIAMOND DRILL CORES.

Operators of diamond drills have long been familiar with the distinct riflings or thread-like markings which are noticed on the cores under certain conditions and are generally ascribed to vibrations of the drill rod. Although these riflings show peculiarities, being sometimes left-handed, when the bits revolved to the right, the problem does not appear to have received much study. When the attention of Dr. Walter Crane, of the Pennsylvania State College, was drawn to the matter, he communicated with 20 diamond drill companies, and was supplied with many interesting specimens, on which he presented a paper to the American Institute of Mining Engineers (Bulletin of this Institute, May and October, 1916). The number of threads to the turn varied in wide limits, from 3 up to 13; five threads seemed to be most common; even numbers of threads were rare; the pitch of the threads ranged from $\frac{7}{16}$ to $3\frac{1}{16}$ in.; the depth and shape of the thread also varied much, from $\frac{1}{100}$ to $\frac{1}{16}$ in. Sometimes the apparently single threads were double or triple; the deep threads of one pitch were occasionally crossed by less striking lines of a smaller pitch. Generally the rifling was uniform over the whole length of the

core submitted; in some cases the pitch changed suddenly, after a time reverting to the original pitch. In discussing the various possible causes of the rifling—vibration of the drill rod; number of stones in the bit; up and down action of water currents carrying cuttings; particles of mineral or metal working their way down through the core barrel; differential action between core and core barrel, the former having been broken off and turned through friction with the revolving bit and core barrel; overset of the stones in the bit—Dr. Crane arrives at the conclusion that the well-known torsional vibrations of the drill rod are the chief cause of the rifling, and that reduction of the speed of rotation would reduce the vibration, and thus the rifling. The cutting action of particles of mineral or metal lodging in the bit or core, and the excessive overset of the stones in the bits would be accessory causes. In confirmation of his conclusion Dr. Crane imitated the rifling on lathes by fixing a piece of pipe in the chuck of the lathe and leaving the other end of the pipe free or supporting it by the tailpiece of the lathe. When the cutting tool was made as short as possible the conditions were the reverse of those in diamond drilling, but the resulting rifling was distinct, as was to be expected; when a long, slender tool was used on a smooth diamond drill core, the conditions were fairly analogous, and similar, though rough and indistinct, threads were obtained. Commenting upon this communication (in the October number of the Bulletin), Mr. H. M. Roberts, of Minneapolis, points out that the cutting agent must be one or more of the diamonds, and that the wall of the drill-tube must itself be rifled, which he proves by specimens. Diamond setters, he remarks, placed the outside stones of a bit very accurately to gauge, but seldom used a gauge in setting the inside stones; and those stones which projected from the immediate interior and exterior edges of the face of the bit would be responsible. The protuberances of the stones would increase as the metal wore away, and the diamond wear and loss of metal were known to increase in a bit which had produced rifling. Mr. Roberts had counted up to 20 threads, both in even and odd numbers, and right and left-handed; he attempts to approach the problem mathematically also with regard to the question why the rifling is left-handed sometimes, and the cores appear pentagonal in certain cases; but he finds that too many factors enter. The motion of the bit would be of the type of a harmonic motion, and its violence might be broken by varying the speed of the rotation. To reduce the development of a resonant wave motion and to make the bit work straight ahead, he would—following the practice of experienced drillers—use stiff new rods and a blank bit with the smallest possible excess in diameter over the size of the rods; he would also reset the bits frequently, to avoid deformation of the weakened steel.

LITERATURE.

(1) *The American Petroleum Industry.* By RAYMOND FOSS BACON, Ph.D., and WILLIAM ALDEN HAMOR, M.A., with special chapters by F. G. CLAPP, ROSWELL H. JOHNSON, J. P. CAPPEAU, and L. G. HUNTLEY. New York: McGraw-Hill Book Company, Inc., and London: Hill Publishing Company, Limited. 1916. 2 vols. [Price 42*s.* net.]

(2) *Oil-Field Development and Petroleum Mining. A Practical Guide to the Exploration of Petroleum Lands, and a Study of the Engineering Problems connected with the Winning of Petroleum.* By A. BEEBY THOMPSON, M.I.Mech.E., M.Inst.M.M., F.G.S. London: Crosby Lockwood and Son. 1916. [Price 25*s.* net.]

THOUGH the petroleum industry is of very modern growth and its complete history must be within the memory of many now living, yet the rapidity with which it has acquired its present gigantic proportions and its intimate connection with various branches of commerce over which it has exercised a fructifying influence, makes the tale of its onward progress difficult to follow in detail, and the preparation of a comprehensive survey of its many ramifications an arduous task. Science, pure and applied, has been necessary to detect the secret reservoirs in which the crude oil lies hid, while an alert and enterprising commerce, fostered by a generous and on the whole well-regulated finance, has opened up new channels by which its beneficent effects have been widely spread and made the product a distinct factor in advancing civilisation. The authors limit their investigations to the United States where necessarily similar processes of mining, refining and distribution have been followed, in that long chain of oilfields that extends across the continent from Virginia to California. But in matters with which they are less familiar they have welcomed the services of recognised experts in order to present authoritatively some of the particular features of this quick-growing industry. Thus Mr. Greve supplies information concerning drilling methods and appliances; Mr. Clapp writes on the geology of petroleum; Mr. Roswell H. Johnson contributes two thoughtful chapters on the valuation of oil properties and on efficiency in the production of petroleum, respectively; while Mr. Cappeau is responsible for the discussion of the commercial factors involved in the appraisement of petroleum properties, and Mr. L. G. Huntley considers the causes of the decline in productivity of oil wells and suggests some methods by which their yield may be prolonged. These are all important subjects, and are by no means to be regarded as an ornamental fringe round the authors' work, properly so-called. This enumeration may serve in some measure to indicate the wide scope and thoroughness of the treatise, but is imperfect inasmuch as it leaves untouched the large subject of technology in the obtaining and handling of oil, its refinement and distillation, and the various problems—physical and chemical—that are pressing for solution. The history of the industry, which partakes of something of the nature of a romance, the part played by the shale oil industry, the economic treatment of natural gas and some other hopeful lines of development, are handled by the authors with a completeness and mastery of detail that evidences their close connection with the most recent practice. It will be admitted that no small programme is submitted to our consideration, and if we are able to touch on only a few of the more interesting problems raised, it is not that we undervalue the advantages attaching to a unity of treatment of a complicated subject, or are indifferent to the more ample illumination due to a well-considered and contrasted arrangement of the several parts.

Most writers on this subject think it required of them to attempt some explanation of the origin of petroleum, of its general dissemination, and accumulation in bulk. The genesis of the oil possesses more than an academic interest, and if the problem could be completely solved, geological study would be more effective, but it must be admitted that the certainty of demonstration is wanting. Too many theories, ingenious and plausible, hold the field, and offer the luxury of choice. The cosmic theory, which would regard petroleum as due to the combination of the carbon and hydrogen that circulated in the primæval fluid magma of the earth's constituents, is not impossible, but it finds few supporters. In a molten globe at a high but falling temperature carbides would be among the first compounds to be formed, and might well remain in their initial condition through geologic ages, till a later stage of the earth's crust permitted the passage of percolating waters, with results that the chemist can predict. Some weight attaches to the fact that hydrocarbons are found in meteorites, and as illustrating the very general distribution of the combination it is not unimportant to remember that there is no geological system from the Quaternary to the Cambrian from which petroleum is absent.

The chemistry of the carbides has led to the proposal of other inorganic theories to explain the origin of the oil, and though some support for these can be derived from laboratory investigations, the theories, however plausible, fail to establish convincingly that the processes suggested would account for the enormous accumulations of petroleum that are being worked. Indeed, it has been asserted that no important petroleum field has derived its hydrocarbons solely from inorganic sources, and this assertion is probably justified.

It may be doubted whether the supporters of an organic theory are in much better case than their rivals, although their views are more favourably received by a great number of authorities. Accord is a very fickle guide, and the pendulum of general approval may easily swing in an opposite direction. While it is impossible to determine the quantity of organic matter that would have been available at any one time or in the aggregate, yet the coal measures testify to the abundance of vegetable matter that was available for their formation, and it may be conceded that the past ages have furnished an adequate supply of organic material from which petroleum could have been derived by some putrefactive process that would effectually eliminate the nitrogenous compounds. Explanation must, however, be offered for the complete absence of these compounds in petroleum and associated waters, and some authorities have found it necessary to appeal to anærobic bacteria for the accomplishment of the process of deoxidation at comparatively low temperature. The anomaly of excessive saltness with complete absence of sulphates is not without its difficulties, but the resources of the chemist are equal to the demand, though whether these same resources are not unduly taxed to explain the presence of sulphur, sulphuretted hydrogen and other compounds may be questioned. Our authors are content to put the various theories before us for selection, but wisely leave our choice unfettered. Of course it is not improbable but that various causes have been operative at different times on different materials, and the somewhat sharp division between oils having a paraffin and those having an asphalt base points to a possible divergence of origin. A more decisive test may possibly be found in the optical activity of some petroleums, though crude oils do not show this movement to any great extent. Competent authorities have suggested that the petroleum of Pennsylvania is due to marine vegetation, and the Californian oil to animal remains, but the evidence for this refinement is inconclusive. In all these speculations, however, it is possible that too great attention is paid to the visible and commercially valuable accumulations that loom so large on the horizon of the engineer and the capitalist, while the key of the whole problem may be hidden in the comparatively insignificant but widely disseminated shales and limestones, which, though apparently but slightly impregnated with bitumens, yet by reason of their massive bulk contain a larger quantity of petroleum than is offered by the visible oil pools of commerce.

If the source of the oil and the mode of its origin were known, the geologist would be in a better position to offer assistance to the oil engineer; without such knowledge the surface indications may prove misleading. The seepages, the natural gas springs, and other superficial guides recognised by the expert cannot be definitely relied upon to locate the existence of oil in commercial quantities, or to lead the prospector to the main deposit of petroleum below the surface. We have heard much about the "anticlinal" theory, and doubtless in the early days of the industry such a theory was of use in locating oilfields, but it may well have been the means of overlooking others. If petroleum accumulations are particularly frequent where "anticlinal" and "synclinal" structure exists, the explanation may be that this geological feature has been closely studied while other clues were neglected. It is now admitted that, in any accumulation based on geologic structure, "the structure of the productive stratum itself must be considered independently of the configuration of the surface or structure of any surface formation." Mr. Clapp provides a classification of the various types of geological structure with which petroleum has been found associated, and doubtless this system, admirable as it appears, will have to be modified or extended as the critical and determining conditions are better understood. The subdivision included under "quaquaversal" structures, a term that includes the saline domes of Oklahoma, and all formations in which the oil sand dips away in all directions, is very instructive, and will repay close attention.

However great may be the difficulties in determining the position and the possibilities of an unexplored oilfield, they have been successfully overcome in the United States, where the output has attained gigantic proportions. Figures are

inadequate to convey an accurate picture of the extent and value of the industry. The total output since 1858 is three-fifths that of the world's total supply, and the proportion is increasing, for in 1914, the last year for which we have accurate statistics, nearly 70 per cent. of the entire marketed production of crude petroleum came from the United States. Expressed in barrels of 42 gallons capacity, the yield of 1915, including 24,000,000 placed in field storage, is estimated at 291,000,000. Astronomical units may be invoked to convey an idea of such a collection of barrels. If used as milestones they would extend far out in space beyond the orbit of Mars, and would approach Jupiter when he is in opposition. The handling of such enormous quantities indicates huge financial transactions, and the withdrawal of an appreciable fraction of the whole hints at a radical change in the economic conduct of the oil industry. The time seems to be approaching when the cost of production of the oil in many districts will exceed its selling price, and the incentive to active drilling and expansion will be wanting. In California, consumption approximately balances production, but in Oklahoma the yield has been so great that oil can hardly be said "to have an instant spot value." The inherent speculative tendency may, however, be counted on to ensure the prosecution of continued exploration, though further drilling may be neither logical nor expedient, and such risky investment will be encouraged by fixing the price of oil by artificial means. In 1901, oil in Texas could have been sold at a profit at 10 cents a barrel, but the market price has never fallen below half a dollar a barrel, and for many years the price has fluctuated but slightly on either side of 1¼ dols. The influence of the Standard Oil Trust is reflected in this steadiness. The demand for the commodity is, however, by no means exhausted. In the States the consumption of kerosene is 7.3 gallons per head per year. In England, half that quantity suffices, and in other countries the quantity gradually diminishes till in China only 0.4 gallon is used *per capita*. If the Chinese consumption should ever reach that of the States, the demand for kerosene in that country alone would be three times the total yield of crude oil now produced in America.

Improved methods of transport, both by land and sea, have been necessary to handle the enormous output. The authors' description of the evolution of the pipeline and of the tank steamer, with the causes that have led to this expansion, makes very interesting reading. Many passages marked as showing evidence of enterprise or for unexpected results must be omitted on account of space.

Very instructive, too, though of greater practical advantage in America than in this country, is Professor Johnson's discussion of the valuation of oil properties, and of the importance of efficiency in the production of petroleum. The general method of acquiring a right to drill and property in oil is by leases, whose conditions vary in different States. To fix regulations and rates of royalty that should be applied rigorously and indiscriminately to a number of oilfields would be impossible, and if attempted would hamper enterprise. The natural but unfortunate attempt to adapt mining regulations to the exploitation of petroleum is responsible for some of the confusion and waste that now exists, but the recognition of exigencies that do not occur in metal mining is producing improved results. Professor Johnson remarks, however, that the method of leasing in practice to-day is peculiarly wasteful, because the royalty to be paid to the landowner is a fixed percentage. Some kind of sliding scale, he urges, should be adopted in order to reduce the rate as the life of the well diminishes. The general method he recommends is to reduce the royalty rate by a definite amount when the well produces less than a specified quantity per day. Into the advantages of this or of some alternative system we cannot enter here, but these chapters are recommended to those who invest in oil shares while little informed of the legal and economic regulations that govern the management and control the life of the wells.

The causes that lead to the decline of oil, whether from natural causes or bad management, need to be considered both by the investor and the economist who would promote the welfare of the industry. In this work facts are set out that will permit either to arrive at an intelligent judgment. The waste that has resulted from ignorance is appalling. Valuable residuals, regarded at the time of mining as a costly burden, have been burnt by the million tons, and these residues would now be harvested as the most marketable product of the wells. The gasoline industry, which within the last few years has attained very considerable dimensions, has arisen from the utilisation of products that were long considered useless. Waste of material and of capital has come from the feverish energy of the lessors, working against one another to extract the most oil possible before a neighbour had a chance. In the newer fields the leases are usually of 40 acres, and very much larger areas are under uniform management, but where the leases were of small extent the holders drilled as many wells close to the next station as possible, compelling the next owner to put down well for well in self-protection. The proper spacing for wells or the effect of proximity was utterly disregarded. The authors throw some light on human nature as well as on oil management. Fortunately, there are many signs of improvement: reckless extravagance has brought its own remedy. Increased working costs and the enhanced value of petroleum will not prove unmixed evils if their effect is to bring about decreased expense and encourage a truly economical exploitation of petroleum resources. The spacing of wells, their construction and casing, the encroachment of water and its control, the conservation of gas pressure, the methodical cleaning of wells, and improved modes of pumping are all matters that have been too much neglected in the days of overwhelming plenty. The authors will have rendered a very essential service if they succeed in forcing these and many other hardly less important factors on a public that in a race to secure the booty has neglected indispensable safeguards.

We have attempted to indicate some of the directions in which the several writers have pursued the subject of the oil industry. Intimate acquaintance with its many branches is shown on every page, but nowhere is the knowledge better systematised and the arrangement of pertinent facts more clearly exhibited than in those chapters dealing with the constantly varying technology of oil-well practice and oil refinery. Into these departments of practical work, in which the details vary from day to day and processes grow obsolete almost before the necessary apparatus is erected, it is impossible to follow these efficient guides. We can only say that a valuable collection of material is at hand, accompanied by well-selected illustrations of machinery that make the text easy to follow. It may, however, be said that the authors do not content themselves with simple description; they are not among those who are satisfied to let the trade drift on hackneyed lines, relying on the exacting demand for maintaining present products and perpetuating the favourable conditions under which the raw material is garnered. They are prominent in that small army of progressives who believe that research will pay, scientifically and financially, that the part petroleum will occupy in the world of commerce is of ever-increasing importance, and that it would be dangerous to fix a limit to the valuable products that will be derived from its distillates. Steeped in knowledge of the achievements of the past, and confidently persuaded of a greater development in the future, Messrs. Bacon and Hamor not only inform but inspire the student with encouragement, and satisfy the most ardent curiosity.

Mr. Beeby Thompson is well known as an authority on oilfield development, and his professional duties have carried him into all parts of the world where petroleum is being exploited. We profit by this wide experience, for in this work now before us he is able to overlook a broader area than in the preceding treatise. As a necessary consequence the detail is not so thorough and minute, and while in some respects it can be regarded as a complement to the work of Messrs. Bacon and Hamor, in others it is a repetition.

In an opening chapter of great interest the author reviews the geographical distribution of petroleum throughout the world, a review that invites us to picture the impetus the possession of this great natural asset has given to the industry of those nations who can draw largely on readily accessible deposits. Considering how wide-flung are the boundaries of the British Empire in all latitudes and climates, it is disappointing to note that up to the present the latent stores of petroleum are very sparsely scattered over our dominions. From Burma the yield is satisfactory, Trinidad and Barbados may prove productive, but Canada, from which much was expected, hangs back. New Zealand has some fields, but Australia and the British Colonies in Africa are practically barren. We might fare better if carbonaceous or bituminous shales, needing distillation for the production of a hydrocarbon, should become a serious rival to oil wells, but that such a fate should overtake the native oil industry is unlikely, though not impossible, for petroleum must, like other minerals, be regarded as strictly limited in quantity, and, moreover, rapidly increasing demands prevent the adoption of well-considered means for conserving the supply. Oil shales, on the other hand, could be mined and distilled for the production of oil by a process as safe and sane as the mining of coal, but the speculative thrill attaching to oilfield prospecting and the hope of sudden wealth hinder the unexciting development of oil shales.

Mr. Thompson, however, has little to do with the conserving side of the industry. His object is to explain how the oil may be detected in its underground hiding-place and brought to the surface. He covers much the same ground as the previous writers in his description of the chemistry of petroleum, the geology of oilfields, and the surface indications that declare or suggest the presence of oil. His experience is far-reaching; he does not limit himself to the conditions that obtain in any one country, and the comparisons that can be made between different methods that have been successfully adopted over widely separated areas are both suggestive and informing. Having found the oil, he describes the systems of drilling and boring, and here he speaks with the authority of a master. In some of his earlier works the author has been inclined to linger over the methods in which he himself has taken part, to the exclusion of other, and sometimes newer, modes, but this defect has been remedied. The methods in practice are generally determined by the geological formation of the district in which the operations are carried on, and the technical methods, however varying, may be regarded as localised and fixed in principle under like conditions. The character of the casing or the lining tubes, fixed with the object of excluding water or preventing soft formations from caving, is also determined by geological conditions. The practice followed in different fields, with the reasons for adopting particular precautions, is well explained. In Russian fields, where the strata are especially incoherent, the diameter of the well is purposely made large and the casing inserted and reduced in size at comparatively short intervals. In the more easterly United States oilfields it is possible to drill occasionally 2,000 ft. without encountering difficulties that compel the lining of the boring. The author insists rightly on the need of trained judgment and wide experience in meeting the ever-changing conditions that new undertakings entail, and it is not the least of the merits of this treatise that he keeps prominently in view the interests of the owners or promoters. The business of drilling and extraction should be regarded as a purely commercial proposition. In this connection it may be mentioned that a very practical chapter on oilfield organisation and accountancy has been contributed by Mr. Percy R. Clark, the illustrations and details being apparently drawn from actual experience.

Although the exclusion of water from wells is a necessity under normal conditions, and the neglect of proper precautions has led to oilfields of great promise being abandoned owing to the large volumes of water which have entered the wells and displaced the petroleum, it should not be overlooked that under some circumstances very great advantages may attend the flooding of an oil district. It has been frequently asserted, and occasionally tested, that flooding may be the only way of extracting oil from rock. The author might have dwelt more

fully on this very practical question. An oil-bearing stratum is practically a sealed reservoir, and as oil and gas are voided, some substitute must be provided in their place. The expansion of gas, or air admitted through the wells, may effect this replacement, but with lapse of time, water, whether fresh or salt, usually occupies the exhausted space. Attempts to flood an oil-bearing formation have frequently failed, and the method has been somewhat discredited, but the lack of success cannot be attributed to erroneous theory so much as to inexact knowledge of the underground conditions, the impossibility of predicting the movement of the oil, and often the conflicting interests of adjacent lessors. Deliberate flooding with the consent of the owners, undertaken as a resort in the last extremity, is to be regarded very differently from the mischief to be dreaded from water seepage and the entrance of water from causes which can be effectually prevented by due care in cementing, capping, and other devices, all sufficiently explained here.

Mr. Thompson has produced a book replete with so much information and so valuable to the large class interested in the technique of oil exploitation, that it seems ungracious to dwell on small defects. But the author's active duties in the field have perhaps prevented him giving close attention to the literary part of the work. The arrangement might be improved, and there are repetitions which may displease the fastidious, while a more complete blending and digestion of the facts would have removed some crudities that disfigure his work.

BOOKS RECEIVED.

United States Geological Survey. Water Supply Papers. No. 332. *Surface Water Supply of the United States, 1912. Part XII. North Pacific Drainage Basins.* By NATHAN C. GROVER, F. F. RENSHAW, G. C. BALDWIN and W. A. LAMB. No. 369. *Water Powers of the Cascade Range. Part III. Yakima River Basin.* By GLENN L. PARKER and FRANK B. STOREY. No. 374. *Ground Water of the Hartford, Stamford, Salisbury, Willimantic and Saybrook Areas, Connecticut.* By HERBERT E. GREGORY and ARTHUR J. ELLIS. No. 375-G. *Ground Water in Lasalle and McMullen Counties, Texas.* By ALEXANDER DEUSSEN and R. B. DOLE. No. 383. *Surface Water Supply of the United States, 1914. Part III. Ohio River Basin.* By NATHAN C. GROVER, ALBERT H. HORTON and WARREN E. HALL. No. 398. *Ground Water in San Joaquin Valley, California.* By W. C. MENDENHALL, R. B. DOLE and HERMAN STABLER. No. 399. *Geology and Ground Waters of North-Eastern Arkansas.* By LLOYD WILLIAM STEPHENSON and ALBERT FOSTER CRIDER, with a *Discussion of the Chemical Character of the Waters.* By RICHARD B. DOLE. Washington: Government Printing Office.

Spons' Electrical Pocket Book: A Reference Book of General Electrical Information, Formulæ and Tables for Practical Engineers. By WALTER H. MOLESWORTH. London: E. and F. N. Spon, Limited; New York: Spon and Chamberlain. [Price 6*s.*; post free, United Kingdom, 6*s.* 5*d.*]

Keighley Association of Engineers: Sixteenth Annual Report. Keighley: F. Dunderdale and Co., Limited, Cavendish-street. [Price 6*d.*]

Meccanico Moderno, Guida Pratica del: Manuale Teorico-Pratico. By A. MASSENZ. Milano: Ulrico Hoepli. [Price L.4.50.]

Tempera e Cementazione dell'Acciaio. By M. LEVI-MALVANO. Milan: Ulrico Hoepli. [Price L.4.]

Strength of Ships. A. J. MURRAY. London: Longmans, Green and Co. [Price 15*s.* net.]

Midland Institute of Mining Engineers. Catalogue of Library, Subject-Matter Index of Papers and of Articles on Mining and Allied Subjects. Sheffield: The Midland Institute of Mining Engineers.

ENGINEERING WORKS IN BELGIUM.—On page 512 of our last volume we reproduced part of an article in *The Times*, written by a neutral commercial agent, stating that "the great Cockerill Works at Seraing were taken over immediately after the fall of Liége." We are informed that this is incorrect, for since the commencement of the war the Cockerill Works have been run entirely by their own management; they have been completing orders which were in hand before the war, and are also working for export to Holland.

THE ABSORPTION OF SECOND-HAND RAILWAY MATERIAL FOR WAR PURPOSES.—The Minister of Munitions orders that the war material to which the regulation applies shall include war material of the following classes and description, namely:—Second-hand railway material, including locomotives of all types, wagons of all types, rails of all sections and types, chairs, fish plates, fastenings, signal apparatus, sleepers and the like. All applications for a permit in connection with the above Order should be addressed to the Deputy Director-General (Railway Materials Licences), at the Ministry of Munitions, Whitehall Place, S.W.

THE LATE MR. WILLIAM MACMILLAN.

WE regret to have to record the death of Mr. Wm. MacMillan, who may be regarded as one of the pioneers who did much to establish the industry of shipbuilding on the Clyde. His father was noted in the industry before him, having been for 30 years manager of the yard of Messrs. Tod and McGregor, of Meadowside, who built many of the earliest of the Atlantic steamers. The subject of our memoir was for 46 years manager of Messrs. A. and J. Inglis' yard at Pointhouse, and for the greater part of that time a partner. Mr. William MacMillan was born and educated in Greenock, and showed early aptitude by taking a medal at the Greenock Academy. He gained his early experience under his father and also in the yard, at Renfrew, now occupied by Messrs. Simons, at a time when there were built there many exceptionally fast steamers for trading on the Clyde, so that here Mr. MacMillan began a connection (which continued until the end of his career) with the construction of the flotilla of paddle steamers which trade in the estuary of the Clyde. As a young man, Mr. MacMillan became manager of Laurence, Hill and Co.'s Inchgreen Shipbuilding Yard at Port Glasgow, and had charge also of the drawing office. His relationship with Messrs. Inglis began at this establishment. That firm had secured the order for building and engining the Tasmania, a notable Atlantic mail steamer of her day. The hull of the vessel was built by Messrs. Laurence, Hill and Co., while the engines were constructed by Messrs. Inglis. It was in 1862 that Messrs. Inglis began shipbuilding, and they invited Mr. MacMillan to organise and manage their new yard at Pointhouse. Soon after that the present Dr. Inglis, when he became 25 years of age, joined the firm, and from that date forward there was a close personal friendship between the late Mr. MacMillan and Dr. Inglis. The one had passed through a course of scientific study at the university, while the other was already an experienced shipbuilder, and it was not therefore surprising that the shipbuilding yard rapidly progressed and did work not only of an original type but of high renown for its sound practical qualities. Mr. MacMillan later became a partner. He belonged to the old school in respect that his relationship with the workers was intimate and friendly. Many aspirants to higher posts received from him great encouragement, and consequently his death will be heard of with widespread regret. Mr. MacMillan was of a most retiring disposition, although his geniality made him a most desirable friend. He was a Unionist in politics, but took little part in public affairs. He retired in 1910, and died on the 23rd ult., at his residence in Glasgow, at the advanced age of 80 years. His wife survives him, and together they celebrated their golden wedding in July of last year.

ALUMINA IN CROATIA.—About three years ago deposits of alumina were discovered at Bruvno, near Rudopolje in Croatia, Austria, and the mineral was declared by experts to be as good as bauxite from Baux and to contain 66 per cent. of metallic aluminium. Exploitation of this hydrate was at once planned, but the war interfered. Aluminium works are now to be erected; the power is to be derived from some lakes 50 km. distant. Aluminium nitride is also to be made.

NAVAL DECORATIONS.—The *London Gazette* of last Monday contains a list of additional honours and commendations for service in the Battle of Jutland and in miscellaneous work by the Navy. We note that a large number of engine-room artificers have received recognition for their work, and we congratulate this branch of the service on the decorations conferred, of which we give a list:—*Jutland Battle*:—To receive the Distinguished Service Medal, Chief Engine-Room Artificers Frank Dymond, Herbert Neal, William Ford and Robert Charles Lees; Engine-Room Artificer Edward Frank Roser. Commended for their services: Engineer-Captain Archie Russell Emdin, Chief Engine-Room Artificer Frederick Charles Selway, Acting Chief Engine-Room Artificer Archibald Frank Tammadge, Engine-Room Artificers John Friend Kellaway, George Henry Langmead and Henry Cameron Booth. *Mine-Sweeping Operations*:—To receive the Distinguished Service Medal: Engine-Room Artificer Albert George Pearson. Commended for services: Engine-Room Artificer George Robert John Lighton. *Submarine Service*:—To receive the Distinguished Service Medal: Acting Chief Engine-Room Artificer Alexander Weir, Engine-Room Artificers Sidney Lewis Dole Frampton and Alfred Alexander Truscott. Mentioned for good services: Engine-Room Artificers Gilbert Oxley, Edward Frederick Cowley and Robert Alfred Wilson. *Miscellaneous Services*:—To receive the Distinguished Service Medal: Chief Engineer Frederick Livingstone Angus, Chief Engine-Room Artificer Albert Charles Burton, Engine-Room Artificer Frank William Crabbe, Electrical Artificer Henry Frederick Williams, Mechanician Harry Clifford Curtis. Mentioned in Despatches: Engine-Room Artificer Hubert Berry. *Belgian Orders for Services during the War*:—Ordre de Leopold II: Chevalier: Chief Engine-Room Artificer Samuel Abbott Earle, Engine-Room Artificer Robert Alwyn Wainwright.

THE LATE MR. ARTHUR JAMES IRELAND.

WE briefly announced on page 636 of our last issue the death of Mr. Arthur James Ireland, and we are now able to give a few particulars in his career. Mr. Ireland was born in Northampton 57 years ago. In 1879 he went to America, and subsequently joined the American Brush Company, Akron, Ohio. He installed a number of "Brush" arc lamps in various parts of the West and in Texas. Leaving the Brush Company, he became associated with the Thomson-Houston Company, Llynn, Mass., and when this latter company commenced the introduction of their lighting system abroad Mr. Ireland was appointed European expert to the Thomson-Houston International Company, who were engaged in carrying out various important contracts for arc-lighting plant on the Continent. It was while acting as their representative at Turin that he was summoned to England in 1885 to carry out work for Messrs. Laing, Wharton and Down, who had acquired the patent rights of the Thomson-Houston system in the United Kingdom. He was retained permanently on the staff of Messrs. Laing, Wharton and Down, acting as their chief engineer in connection with the installation of arc-lighting systems at various places, including the installation at the American Exhibition at Earl's Court in 1887 and at the Italian Exhibition in 1888.

Mr. Ireland, as chief engineer, took an active interest in the pioneer installations of the Thomson-Houston arc lighting at Taunton, Bath, Bristol and other centres in the West of England, and had charge of the installation to provide the grounds and buildings of the Military Exhibition at Chelsea with electric light. He also carried out some of the early work at the stations and goods yards of the Midland Railway Company at St. Pancras, Leeds, Bradford and Derby.

In addition to the above he was responsible for some of the early central station plant put down, such as at Weybridge, Fareham, &c.

In 1890 the contract for lighting the eastern portion of the City of London was awarded to the Laing, Wharton and Down Construction Syndicate, and Mr. Ireland had charge of all this work, embracing the erection of a temporary generating station at Wool Quay, and later on he supervised the erection of the first portion of the equipment of the main power house at Bankside, which was designed to furnish power to the whole of the City of London. He was also responsible for the complete installation of street arc lighting throughout the eastern part of the city, and for the extensive system of underground mains laid down in that area, as well as numerous sub-stations which were erected to give a supply to private consumers.

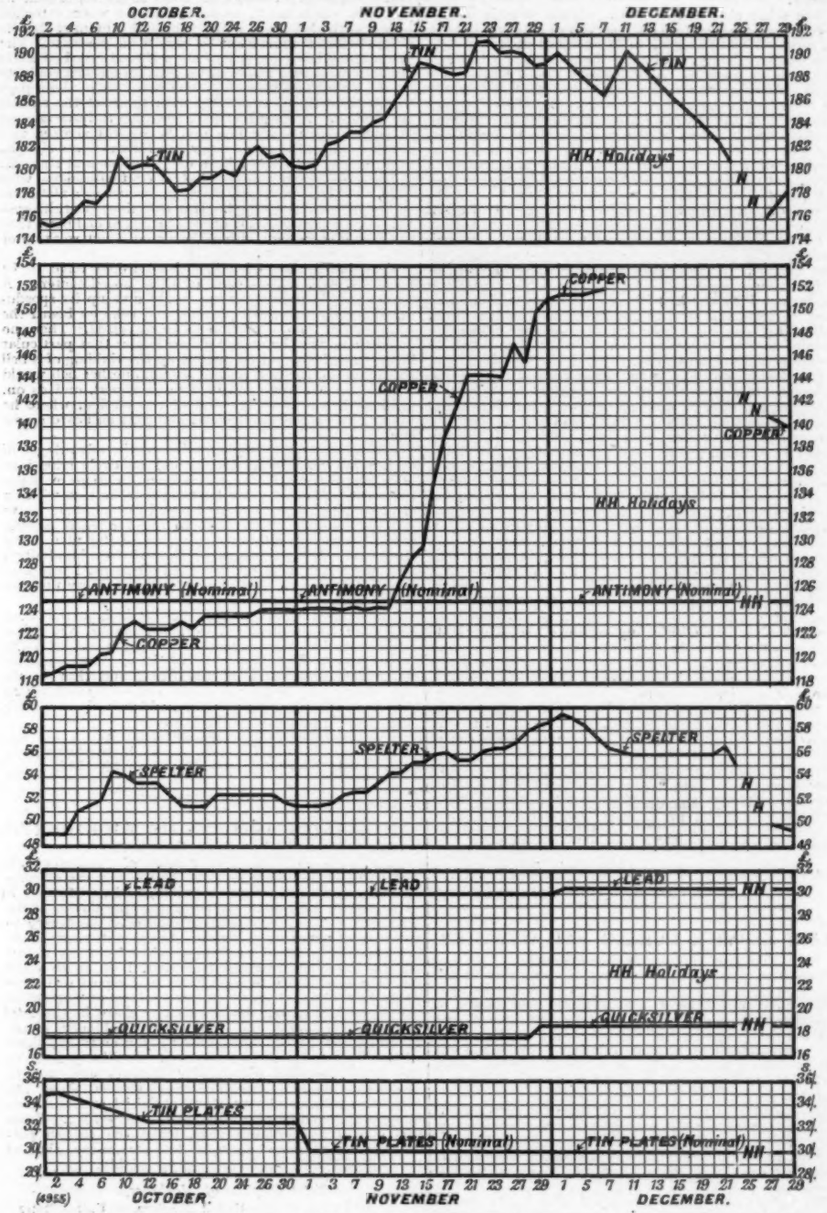
In 1894 the Laing, Wharton and Down Construction Syndicate was turned into the British Thomson-Houston, Limited, and while acting as chief engineer for the latter Mr. Ireland carried out important central station work in different parts of the kingdom, as well as the electrification of tramways in Dublin and elsewhere. In 1896 the supply business of the British Thomson-Houston Company, Limited (the successor of the previous two companies) became so extensive that Mr. Ireland was given entire charge of this work, becoming later also the manager of the various branch offices of the company. Since then he has continued to control this department of the company's business with uniform success.

Mr. Ireland was widely known and respected in electrical and manufacturing circles in the United Kingdom. He was a man of strong character, and all of those who were associated with him, or had any extensive relations with him, were always struck by his honesty of purpose and great sincerity. He was a type of the best of Englishmen, and had the ability to get the best out of all those who worked under him, while still maintaining the most friendly relations with them. Not only his staff, but everyone who came in contact with him knew that his word could be absolutely depended upon.

MAXIMUM PRICES FOR SALES OF SULPHURIC ACID.—A circular letter was issued on December 30, 1916, substituting, as from January 1, 1917, the following maximum prices for sales of sulphuric acid for those set forth in circular letters of February 11 and 28, 1916. These refer to sales of sulphuric acid of all descriptions and for all purposes unless expressly excepted, and the maximum price is in each case per ton for acid delivered into tank-wagon, cart, or barge at makers' works:—Class A, arsenical acid, 140 deg. Tw. at 60 deg. F., 70*s.*; Class B, non-arsenical or de-arsenicated, 144 deg. Tw. at 60 deg. F., 85*s.*; Class C, arsenical, 95 per cent. H_2SO_4, 130*s.*; Class D, non-arsenical or de-arsenicated, 95 per cent. H_2SO_4, 140*s.* Certain recommendations are also made as to allowances for variation in strength, charges for filling and hiring of packages, &c. Further particulars on these points and copies of the circular letter referred to can be obtained on application to the Director of Acid Supplies, Ministry of Munitions of War, Explosives Department, Storey's Gate, Westminster, London, S.W.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal and Scotch Pig-Iron Warrant Markets.)



NOTE.—In the diagrams above the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange, as far as they have been reported, for "fine foreign" and "standard" metal respectively. The prices shown for antimony and lead are for English metal in both cases, whilst those for spelter are for American metal. The prices are per ton, but in the case of quicksilver, however, the price is per bottle; the price of tin-plates is per box of I.C. cokes free on board at Welsh ports. Each vertical line in the diagram represents two market-days, and the horizontal lines represent 2*l.* each, except in the case of the diagram relating to tin-plates, where they represent 2*s.* each. On July 7 the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig was fixed at 6*l.* 2*s.* 6d., Scotch at 5*l.* 14*s.*, and Cleveland at 4*l.* 11*s.* 6d. per ton. Ship-plates were priced at 11*l.* 10*s.*, and heavy steel rails at 10*l.* 17*s.* 6d. per ton. These quotations are still in force. (For official regulations see page 45, vol. cii.)

DETERMINATION OF THE RARE GASES.—An apparatus for the determination of argon and the other rare gases, described by Drs. A. Sieverts and R. Brandt, of Leipzig, in the *Zeitschrift für Angewandte Chemie*, of November 14, 1916, is based upon the observation that metallic calcium at dark red glow will absorb all the gases of the atmosphere except the rare gases. Calcium has, of course, been used for similar purposes for some time. But it may not be generally known that the commercial calcium used for this absorption is sometimes inactive, but can easily be cured and rendered active again by re-fusion. The operation is carried out in an airtight crucible or in a sealed iron tube, under a cover of calcium chloride or, better still, rammed-down calcium oxide; the fused calcium is slowly allowed to solidify to a brittle, coarsely-crystalline metal.

EXPLOSIBILITY OF METHANE-AIR MIXTURES.—Technical Paper 121, of the Bureau of Mines, by Messrs. G. A. Burrell and I. W. Robertson, does not carry this investigation much further than previous publications. The influence of pressure and temperature was particularly investigated. It was found that, with an initial temperature of 500 deg. C., the lower limit of complete flame propagation was between 3.75 and 4 per cent. of methane; with lower temperatures the lower limit rose slightly, to 5 per cent. at ordinary temperature. Initial pressures of 5 atmospheres had no effect on the lower limit; but at reduced pressure (250 or 300 mm. of mercury) the mixtures were no longer ignited by the electric sparks; mixtures of 8.5 or 10 per cent. of methane would, however, propagate the flame at low pressure.

THE PANAMA CANAL.

THE *Panama Canal Record* gives a table, which we reproduce below, showing 158 transits through the Canal in October, from which it will be noted that 86 of the ships, or more than half, were in the Canal between 9 and 12 hours. The percentage requiring over 12 hours was 30.7, and the proportion passing through in less than 9 hours was 15 per cent.

Time.	Atlantic to Pacific.	Pacific to Atlantic.	Total	Per Cent.
7 to 8 hours	3	3	6	3.7
8 to 9 hours	9	9	18	11.3
9 to 10 hours	9	9	18	11.3
10 to 11 hours	13	9	22	13.9
11 to 12 hours	21	25	46	29.1
12 to 13 hours	8	13	21	13.2
13 to 14 hours	7	8	15	9.5
14 to 15 hours	1	4	5	3.6
15 to 16 hours	—	1	1	0.7
Over 16 hours	3	3	6	3.7
Total ..	74	84	158	100.0

The aggregate time of all vessels was 76 days 19 hours 33 minutes, giving an average time for all vessels of 11 hours and 40 minutes. The minimum time was that of the Izabal, 7 hours 17 minutes, and the maximum that of the Nereus, 1 day 8 hours 10 minutes.

The *Panama Canal Record* adds that the cargo carried through the Canal in October, 1916, amounting to 647,893 tons, exceeded the average for the months since the reopening of the Canal in April, 1916, by 79,915 tons; it has been exceeded during but three months since the opening, on August 15, 1914. The number of ships passing through the Canal in seagoing or commercial service (158) was exceeded but twice, in July and August, 1915, when the numbers were 170 and 161 respectively. The following is the classification of the shipping through the Canal in October, according to trade routes:—

Atlantic to Pacific.

Route.	Vessels.	Canal Net Tonnage.	Tons of Cargo.
United States coastwise	3	12,815	14,795
United States to South and Central America	15	44,433	64,555
United States to Far East and Australasia	15	52,386	89,161
Atlantic terminus to South America	16	28,132	16,701
Europe to west coast of South America	5	16,192	17,440
Europe to west coast of North America	3	8,723	12,426
Europe to Far East and Australasia	1	8,628	7,998
Miscellaneous routes	1	4,484	8,000
Vessels in ballast	15	45,817	—
Total	74	221,610	231,016

Pacific to Atlantic.

South and Central America to United States	28	99,866	176,796
Far East and Australasia to United States	6	28,704	38,853
South America to Atlantic terminus	15	28,731	22,309
West coast South America to Europe	21	65,478	110,805
West coast North America to Europe	8	34,639	55,799
Far East and Australasia to Europe	2	13,220	11,115
Miscellaneous routes	1	587	1,200
Vessels in ballast	3	939	—
Total	84	272,164	416,877

Ships in the United States Government service included the naval collier Nereus, bound from Norfolk to San Francisco, and the commercial steamship Brazil, carrying a cargo of coal for the Government, also from Norfolk to San Francisco. The tolls earned in October amounted to 465,949.34 dols. In respect of nationality, the British ships were approximately one-half of the total number; they were nearly three times the number of the American ships and about seven times as many as the Japanese ships, the next highest in number, respectively.

AUSTRALIAN INCOME TAX.—With reference to the effect of the Australian Income Tax Act, 1915, on British firms trading in the Commonwealth, H.M. Trade Commissioner in Australia has telegraphed to the effect that Section 15 of the Act as amended has been cancelled by the Federal Parliament. Section 15 of the Act as amended was worded as follows:—"(1) In the case of a person selling goods in Australia on account of a person not resident in Australia, or on account of a company not registered in Australia, the principal shall be deemed to have derived from such sale a taxable income equal to five pounds per centum upon the price at which the goods were sold. (2) The person selling the goods shall be assessable on the taxable income as the agent for the principal and shall be personally liable for the payment of the tax to the extent of the tax payable on goods sold by him after the thirtieth day of June, one thousand nine hundred and fifteen. (3) Goods shall be deemed to be sold in Australia on account of a person not resident in Australia, or on account of a company not registered in Australia, if any person in Australia receives a commission in respect of the sale of the goods or is paid a salary for obtaining orders for or for influencing the sale of the goods."

ELECTRON, QUANTA AND RELATIVITY THEORIES.

To the Editor of Engineering.

SIR,—"Sesamy's" concept of energy is exactly the same as mine, and that is why I said "energy *or momentum*." I could only see sense in his query on the supposition that he it was who looked upon energy as a separate entity. But he is quite right in insisting on the point, as this particular concept is fruitful of much misunderstanding. Fully-fledged relativist-mathematicians, however, may mix up time, space and energy, and obtain a relative result, such as "A ray of light must be bent in passing through an intense field of gravitation," but to reduce their final results to matter and motion alone is utterly beyond their power. To reduce energy in all its ramifications to matter and motion leads to a material view of the ether which I have partly developed in previous letters, and if, Sir, you will grant me sufficient space, I will now concisely develop to its logical conclusion.

A table of refractive indices will indicate that a formula giving the refractive indices for isomorphous substances with equal specific volumes may be written somewhat as follows:—

$$R = R_1 \sqrt[2]{\frac{D}{D_1}},$$

Where R_1 = the refractive index and D_1 = the density of that most refringent of all bodies, the diamond. This should apply to homogeneous media like water as well as to any isotropic crystal. Double refraction in crystals with unequal axes is sufficiently dealt with in the usual manner by means of Fresnel's double-sheeted wave surface, giving the relative distortion of the two plena. With carbon compounds the *atomic* refractions of the monovalent elements are constant, but a suitable factor may have to be added to the above formula for polyvalent elements, whose atomic refraction increases by almost constant increments through their so-called double or treble linking. The specific density of the ether is immediately deduced from this, I believe, original formula as equal to 0.575 by putting R = unity, $R_1 = 2.4669$ and $D_1 = 3.5$. This at least is in the direction of the truth; which can hardly be said for those two famous determinations, one of which places the density of the ether at less than one millionth of that of gaseous hydrogen, and the other at more than 1,000,000 times that of solid platinum. Unfortunately, neither my own rather ancient text-books nor those of the municipal library here give the refractive indices of any of the liquefied permanent or inactive gases, nor, with the exception of hydrogen, of their density. The density of liquid hydrogen at something less than − 234 deg. is 0.07, and the refractive index, if this formula applies, should be less than unity, namely, 0.348. This would make liquid hydrogen of less density than the ether, which at first sight seems improbable, but it must be remembered that liquefied oxygen and carbon dioxide, for example, contract with decrease of temperature much more rapidly than even gases do for the same decrement, so that these must be more in the nature of an explosive than that of a stable liquid.

In diamond the carbon atoms are arranged exactly the same as that described for one plenum of the atomic ether. Assume that there are four atoms of ether to every atom of carbon in a diamond, and that the atomic mass of the ether = ¼, as it is obviously less than hydrogen. Let C, V, M = velocity, volume and mass of the ether atom, and c, v, m of the carbon atom respectively. Then at the same temperature $MC^2 = mc^2$, or $C = \sqrt[2]{24}\,c$. This is the relative atomic velocity. The effective atomic volume caused by similarly-pathed vibration in three dimensions will increase with the cube of the speed, assuming that no time is lost by impact. Therefore $V = \sqrt[3]{24}\,v = 1.89\,v$. (We thus have a method of determining the specific atomic and molecular volumes of the carbon compounds due to alteration of linkages.) Replace the carbon atom by an ether atom at the same temperature, and the molecular volume, which in the diamond was 1 + (4 × 1.89) = 8.56 is now (5 × 1.89) = 9.45. The molecular weight is 12 + (4 × ¼) and (5 × ¼); so that the relative density = As 14 ÷ 8.56 : 2.5 ÷ 9.45 = As 6.3 : 1. The relative density of the ether, which we previously determined from the velocity of light = As 3.5 : 0.575, or As 6.1 : 1, and this is approximately the same ratio.

The stereometric arrangement of the numerous compounds of organic chemistry may be built up from that of the diamond if every carbon atom is tetrahedrally surrounded by four contiguous carbon atoms and 16 replaceable ether atoms, and likewise every ether atom by four carbon atoms. By losing an ether atom with its tetrahedral vibrations the carbon atom gains an electron, and is then capable of further chemical reaction. Similarly, nitrogen, as a triad, is surrounded by twelve replaceable ether atoms, and oxygen, as a dyad, by eight replaceable ether atoms. The number of replaceable ether atoms relative to each acidic element in the solid or liquid state is thus four, three, two or one, in proportion to Barlow and Pope's combining volumes.

The density of the ether atom, when it escapes into the surrounding ethereal fluid, is not evidenced except as a positive electron, but its weight becomes evident in chemical combination and accounts for the fact that atomic weights are determined to two places of decimals when they should be exact numerals. Prout's hypothesis is correct, but its unit is the atom of the ether and not the atom of hydrogen.

The presence of these ether atoms with the typical acidic elements will perhaps show why the specific heat of carbon, for instance, is so anomalous. At a little less than 10 deg. A., the calculated temperature of space, carbon should scarcely radiate at all, but at higher temperatures the carbon atom, in gear as it were with 16 ether atoms, will produce secondary vibrations—the elastic-solid vibrations of Debije, or which is probably the same thing, the elastic solid vibrations analysed by the diagram (page 515, vol. cii) of the action-quanta theory.

The ether atoms of an acidic atomic domain do not radiate, and are therefore the reservoir of entropy, but can be replaced by hydrogen, with increased atomic weight and slower velocity, producing the secondary vibrations of a positive nucleus. A radioactive atom, therefore, is not an atom within the meaning of the word, but should be described as an atomic domain; and the secondary vibrations of the chemical atom constitutes its positive nucleus, while the loss or gain of ether atoms constitutes the gain or loss of an electron. By chemical decomposition of water an ether atom replaces a hydrogen atom, and the heat generated by recombination is thus a *differential* effect and not an absolute effect as hitherto imagined. But when a positive atom or an electron escapes from a metallic atomic domain, absolute energy is lost and is transmitted across the ether by its own velocity or by the ether pressure in energy-quanta, as the case may be. The fact that the equivalence of a radioactive atomic domain after losing a helium atom is compensated by the loss of two electrons is, from this point of view, sufficient to show that the helium atom, although it may come from the main nuclear vibractory system, does not come from the interior of an atom in the strict sense of that word.

Tetrahedral stability is the great central fact of the universe. It is the unit of the chemical bonds; it is the rigidity of the two ether plena preventing all internal motion excepting atomic adjustments necessitated by the vortex motion of light or gravity. Friction is entirely absent as, except for correlated vortex motion, the atoms cannot revolve. Tetrahedral stability and vortex motion fixes a layer of ether atoms without friction on to the surfaces of a planet of radius-vector a and causes a centripetal motion of ether atoms from every confocal ellipsoid of radius-vector x in the proportion a^2/x^2, and their vertical momentum is transmitted to and through matter by dynamical conduction, thus producing gravity; and $x^2 - a^2$ represents the quadric-surface area of vertically undisturbed ether. There is a vertical component D, a magnetic component H parallel to the axis, and a tangential component 2 p, all mutually perpendicular, and within any region $d\,.\,D + d\,.\,H + d\,.\,(2\,p) = 0$. If the planet be of magnetic material the lines of force representing the magnetic components are slow streams of ether atoms passing through the planet from pole to pole, but if not the result is diamagnetic. In the case of light D and H are both reciprocating vectors, but 2p does not change sign, as (− D) × (− H) also = 2 p. No other atomic motion of the ether is possible.

The hydrostatic and hydrodynamic pressure of the ether is expended as gravitational, electric, magnetic, thermal, luminous and chemical forces; and exhibits itself as hardness in minerals, which reaches its maximum in the diamond, as tenacity in metallic and nitrogenous substances, and as potential energy in explosives.

FRED. G. EDWARDS.

33, St. Ronan's-road, Sheffield, December 30, 1916.

TRAIN SERVICE DURING BAD WEATHER.

To the Editor of Engineering.

SIR,—The man in the street may be permitted to ask why it is that, although railways own the tracks over which their trains travel, and exercise their power of excluding trespassers, wheeled traffic and cattle, yet with the first suggestion of misty or foggy weather their train services have to be slowed down to very much less than walking pace? And how is it that trams, which work without signals and in crowded streets, can travel almost as fast in misty as in clear weather?

The answer is a simple one, but deserves very careful consideration during the present war time, when every effort should be made to improve the transport of goods.

The answer is that our railway signals are so arranged that they cannot be seen in misty, foggy or snowy weather.

Our distant signals on the tops of lofty masts should never have been erected, for they can only be seen in clear weather, and every encouragement should have been given to railway companies to place their signals on a level with the heads of the engine drivers and not further away than, say, 3 or 4 ft. from the side of the track, so that they could not possibly be missed or misread even in the densest fog. I understand that railway engineers admit that they have gone too far in the other direction.

There ought to be no difficulty during this war, both here and at the front, in temporarily erecting low signal lamps close to the line, which could be worked by means of the existing wires or other means. If this were done, then our trains could run practically as fast in foggy weather as in clear weather, provided, and this is an important point, the engine driver knows where he is.

At present an engine driver has to learn by heart the signals which he will have to pass, and it is quite evident that even the most experienced engine driver must sometimes get befogged in foggy weather, when, instead of meeting the ordinary succession of signal lights, he is permanently shrouded in fog and is occasionally startled by fog signals, or by weird sounds or voices from invisible streets or out of invisible signal-boxes. Is it not more than likely that under the changed surroundings, reduced speeds, and long stops, even the most experienced engine driver is likely to forget the order of the succession of the signals, and to lose all sense of distances between them and to move very slowly, although if he were in his ordinary surroundings he would know that he could race along for another half-a-dozen miles with no signal post to stop him.

I would therefore suggest that both here and at the front engine drivers should be provided with speedometers of the following design. A small drum, of the barrel organ type, either of wood or metal, should be provided which has to be actuated by a worm attached to one of the locomotive wheels in such a manner that its circumferential movement is, say, 6 in. per mile. The drum would have one or two screw threads marked on its circumference into which metal pegs for electric contacts would have to be inserted. The positions of these pegs would have to agree exactly with those of the signals on the line. It may be found desirable to have one set of pegs on one screw line for the distant signals, and another set on the other screw line for the home signals, and pegs on both screw lines for junctions and stations.

The pegs would actuate electric contact-makers with bells, and these would draw the engine driver's attention to the approaching signal. If it says lines clear, he goes on, if blocked he stops, if there is no signal he knows that something is wrong; either the signal is not working or he is on a wrong line.

For each section of a line there would have to be provided, say, half-a-dozen of these speedometers. A train entering such a section would give up its speedometer for the traversed portion, and take on board the speedometer for the portion to be traversed. Then, no matter whether the engine driver knows that particular line or not, he would be warned by the tinkling of a bell when nearing the first distant signal, another bell would tell him of the approach of a home signal, and so on, until he has reached the end of the section, where he would give up the speedometer and take on board a new one.

I have in a small way experienced the advantages of such a device. Before setting out on cycle trips into unknown districts I have noted down on strips of paper the cross-roads and other landmarks to be met with on my track, and against these I noted the numbers which my speedometer would have to register when passing them. Whereas, before the adoption of this plan I had often taken wrong turnings, particularly into blind alleys to farms which were not recorded on maps, I was now able to travel with absolute certainty as to my position on the road.

I make the above two suggestions in the hope that they may both be adopted and worked together, but either could be worked independently of the other and yet make our railway traffic independent of the weather, a matter of greatest importance at the front, and they would also enable men to be put on sections of a track which they have never traversed before, which is also a matter of greatest importance at the front.

Yours faithfully,

C. E. STROMEYER.

Lancefield, West Didsbury, December 30, 1916.

AUSTRALIAN IMPORTS OF MACHINERY.

To the Editor of Engineering.

SIR,—On page 302 of your issue of September 29, just to hand, reference is made to the imports of competitive merchandise into Australia, and satisfaction is expressed that in 1915 the percentage proportion of the United Kingdom in competitive exports *of machinery* to this market never stood higher. As the statements made are apparently based on figures taken from my report on the Trade of Australia last year, I desire to point out that a reference to page 25 of that report will show that the statement as to the percentage proportion of the United Kingdom deals with our share in the *total competitive imports* and not with machinery alone. Similarly the percentages given by you as to the share of the United States in imports of machinery refer to the *total* American competitive imports and not to machinery alone. The following figures show the respective values and proportions of British and American imports of machinery into this market since 1912. From this it will be apparent that, while the British percentage has remained more or less stationary, that of the United States has increased appreciably.

Total Imports of Machinery.

	United Kingdom.			United States.	
	£	£	p.c.	£	p.c.
1912 ..	4,771,397	2,510,052	52.61	1,507,662	31.6
1913 ..	4,682,100	2,546,937	54.4	1,397,096	29.8
1914* ..	2,554,039	1,378,733	54.0	851,252	33.3
1914–15 ..	3,806,100	1,988,400	52.2	1,446,744	37.9

* Six months only.

Trusting you can find space for this correction,

I am, Sir, your obedient servant,

G. T. MILNE.

Commerce House, Melbourne, November 15, 1916.

PERSONAL.—Messrs. Irwin and Jones, Limited, of London House, New London-street, E.C., have been appointed sole agents in the United Kingdom and France for the sale of the "Hunt" storage battery industrial trucks manufactured by the C. W. Hunt Company, Inc., of New York City, U.S.A. Irwin and Jones, Limited, will also, as from the New Year, look after Messrs. Hunt's interests for elevating and conveying coal and general merchandise, for which plant Messrs. Hunt have a world-wide reputation, having been engaged in that business for 45 years.—Mr. Coms. Koning, jun., of 82 to 86 N. Z. Voorburgwal, 47A Spuistraat, Amsterdam, has taken his sons, Mr. G. C. Koning and Mr. H. G. Koning, who have already for several years assisted him, as partners into his business.

SLOT-DRILLING AND KEYWAY-CUTTING MACHINE.

CONSTRUCTED BY MESSRS. GEORGE RICHARDS AND CO., LTD., BROADHEATH.

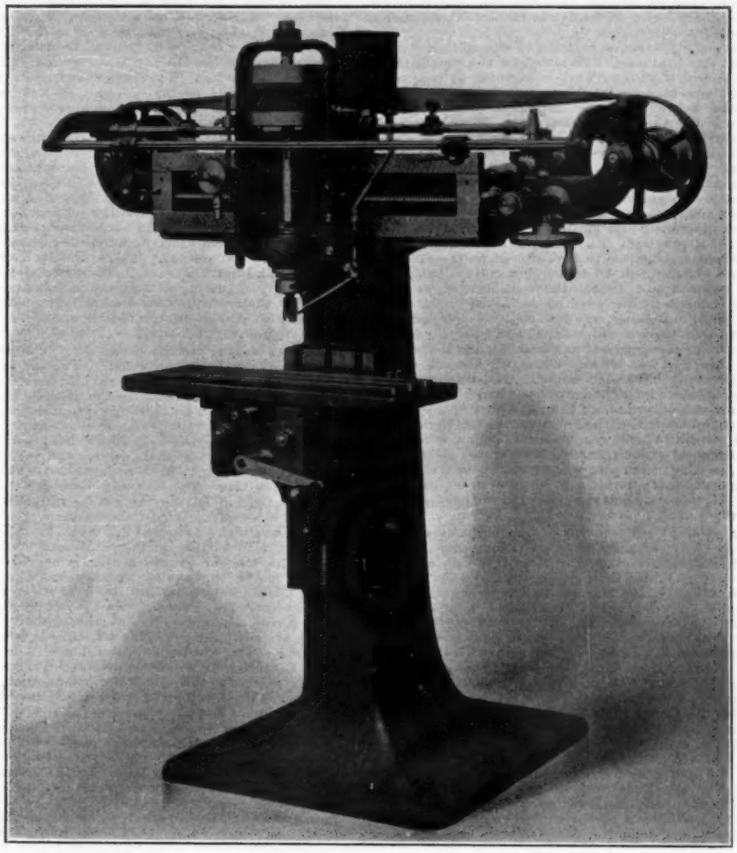


FIG. 3.

THE illustrations, Figs. 1 and 2 on Plate IV, published with our present issue, show a high-speed boring, drilling and milling machine and an example of the Pearn-Richards high-speed surfacing, boring, milling, drilling and tapping machine, built by Messrs. George Richards and Co., Limited, Broadheath, Manchester.

The view, Fig. 1, shows one of Messrs. Richards' high-speed boring, milling and drilling machines with traversing spindle, which is in many respects similar to that illustrated in Fig. 2, to be described later. The machine shown in Fig. 1 is built in two sizes, in the larger of which the spindle has a diameter of 3½ in. and a traverse of 36 in. It adjusts above the revolving table from 6 to 30 in., and above the sliding table from 10 to 34 in. The sliding table measures 51 by 33 in., and the upper revolving table is 33 in. square. The longitudinal traverse is 44 in.; the transverse traverse is 38 in. if automatic, or 42 in. if actuated by hand. There are 24 speeds to the spindle and 16 rates of feed, also 16 rates of feed to the table longitudinally and transversely and to the spindle frame vertically. The machines are fitted with a speed gear-box having single pulley drive.

The Pearn-Richards machine shown in Fig. 2 was originally designed for facing pipe flanges; the range of operations which could be performed on it, however, was rapidly ascertained by the designers, and it is now capable of those stated above. It reduces to a minimum the ratio of time spent in setting up a job to that spent in actual cutting, this reducing the labour charges whilst increasing the capacity of the machine. It is built in five sizes, capable of facing and edging from 18 to 48 in. Taking the largest size, the vertical adjustment above the revolving table is from 8½ to 36 in., and that above the sliding table from 12½ to 40 in. The inwards roughing tool slide feeds are from 25 to 16 per inch, and the outwards finishing feed is 8 per inch, both with a 1¼-in. square tool.

Still speaking of the largest size machine, the lower sliding table measures 87 by 48 in., and the upper revolving table is 48 in. square. The longitudinal traverse with the boring stay in position is 72 in., and the transverse traverse also 72 in. The bed measures 11 ft. 6 in. in length from the face of the upright, and is 4 ft. 3 in. in width, the distance between the boring bar socket and stay being 9 ft. 7 in.

There are eight speeds on each of the four gears, 32 in all, ranging in the largest machine from 1.5 to 160. There are also eight feeds to the table longitudinally and transversely, and to the spindle frame vertically in the progression 100, 75, 55, 40, 20, 15, 11 and 8. The pulley on the spindle has a diameter of 20 in., taking a belt 5½ in. wide.

The machines have automatic feeds to the table longitudinally and transversely, also to the spindle frame vertically, and rapid power traverses to these motions. A stationary controlling hand wheel governs boring and edging. The revolving table is provided with a lifting arrangement. The drive is by a single pulley. The bed can be lengthened and the column and boring stay increased in height to suit varying requirements.

In Fig. 3 on the present page we illustrate a slot-drilling and keyway-cutting machine, built by the same firm. This machine is entirely automatic in its working, and is provided with an automatic stop for gauging the depth of cut. The spindle is driven by belt, to impart a smooth motion to the cutting tool; it has six changes of speed. A hand longitudinal adjustment is given to the spindle frame, actuated by a hand wheel at the end of the slide; this permits of the spindle frame being readily brought to the position required prior to the automatic traverse being set in operation. The machine we illustrate will cut keyways up to 20 in. long and 1 in. wide. The spindle has a self-acting vertical feed of 2 in. The table is 24 in. long and 8 in. wide, and has a vertical adjustment of 12 in., also a cross adjustment of 3 in., to enable the machine to be used for any kind of cotter cutting. The countershaft has pulleys 8 in. in diameter for a 3-in. belt.

KRUPP'S BALANCE-SHEET.

A WEEK or two ago we received particulars regarding the report and financial statement of the Krupp firm, of Essen, and these we have held over pending further inquiries, in order that we might be able to record the state of affairs with absolute accuracy. The dividend has been maintained at 12 per cent., notwithstanding the increase in capital, and this has involved the distribution of 30,000,000 marks, as compared with 21,600,000 marks in the year prior to the war. But it is obvious from close investigation and further inquiry that the firm have made an even larger gross profit than the phenomenal amount realised in the immediately preceding year. The increase, indeed, is over 30,000,000 marks over the preceding year, which, again, showed an enormous advance on that of pre-war times. This increase is not disclosed directly in the profit and loss account. Certain writings-off of an unusual nature have been made before the working profits were arrived at. Thus, for instance, the depreciation of works and plant is put down at 55,143,396 marks, as against 37,980,418 marks for the preceding year. But in addition to this usual item there has been written-off, on war material, shops and plant, 30,000,000 marks, making 85,000,000 marks, as compared with slightly less than 38,000,000 marks for the previous year. There was a further sum written off, on tools, means of transport, &c., which does not appear. Thus, although the surplus of working profits in the profit and loss account shows a decrease of about 17,000,000 marks, the result is really an increase of over 30,000,000 marks, as already stated, on what was a record year in the Krupp concern. It is said, however, that the Krupp concern is not considered to have done, comparatively, so well as some other large undertakings in Germany interested in war contracts, for whom the second year of the war has resulted in the creation of materially-increased reserves and writings-off, as well as, in some cases, of much higher dividends. The following three tables show respectively the receipts, expenditure and distribution of profit from the profit and loss account.

Revenue.

——	1913–14.	1914–15.	1915–16.
	Marks.	Marks.	Marks.
Carried forward from previous year ..	6,926,334	9,385,346	9,477,678
Sundry Items ..	2,051,550	2,505,930	3,670,963
Working profit ..	54,004,570	113,229,822	96,928,938
Interest	2,283,668	3,142,063	3,283,333
Total	65,266,122	128,263,161	113,360,912

Expenditure.

——	1913–14.	1914–15.	1915–16.
	Marks.	Marks.	Marks.
Taxes	9,858,249	10,717,965	28,649,923
Employees' insurance	5,703,984	5,802,282	6,935,117
Welfare expenditure..	8,873,331	15,891,955	18,140,886
Profit, including balance carried forward	40,830,558	95,850,958	59,634,986
Total	65,266,122	128,263,160	113,360,912

Distribution of Profits.

——	1913–14.	1914–15.	1915–16.
	Marks.	Marks.	Marks.
5 per cent. legal reserve	1,695,211	4,323,281	2,482,865
Special reserves ..	2,000,000	3,000,000	2,000,000
Dividends (12 per cent.)	21,600,000	25,800,000	30,000,000
Special writings-off, &c.	—	5,000,000	5,000,000
War losses, &c. ..	—	10,000,000	—
For social purposes ..	6,000,000	16,000,000	9,000,000
Krupp Institution ..	—	20,000,000	—
General War provision	—	3,700,000	—
Commissions ..	150,000	150,000	150,000
Carried forward ..	9,385,317	9,977,678	11,002,121

The Krupp Company has, as will be seen from the above figures, not been able to apply nearly such a large sum in 1915–16 as in 1914–15 for social purposes. In the balance sheet, the works, plant, &c. (after the writings-off have been deducted) are included at 241,628,788 marks; tools and means of transport at 5,400,558 marks; stocks, half-finished and finished goods, at 368,833,955 marks (against 235,244,856 marks in 1914–15); patents and royalties, at 2 marks; fixed interest—stocks, free property, at 117,992,652 marks; fixed interest for war tax, 1914–15 and 1915–16, at 27,994,500 marks.

The share capital is now 250,000,000 marks. The items for payments on account of current contracts and other creditors are naturally much higher than twelve months ago, as are several other liabilities not yet due at the end of the financial year. For the current year a sum of 12,000,000 marks has again been set aside for special aid to functionaries and men on account of the extraordinary conditions prevailing. The pension funds for functionaries and men, which do not appear in the balance sheet, but are kept entirely separate, amounted at the end of the 1915–16 year to 72,772,860 marks, against 60,850,725 marks a year previously.

THE CLAIMS OF LABOUR IN THE ENGINEERING INDUSTRY.*

By J. R. RICHMOND.

ONE of the effects of the war has been to dissipate many comfortable beliefs, to cause us to readjust our point of view with regard to many institutions, to find that many things which we had regarded as stable and permanent are unstable and only relatively stationary in a scheme of evolution. One of the relationships to which many authorities have devoted themselves is that between the employer and the worker. Representative masters and men have expressed themselves tired of industrial warfare, and there is a general desire to readjust the relationship on a basis which will no longer give rise to the constant irritations and struggles of the past. So far only tentative attempts have been made to secure a common meeting-ground from which both parties to the industrial partnership can start discussion. Most of the suggestions to which I have alluded have been made by men outside the industry, eminent as economists, as writers on social subjects, as churchmen, and as politicians, and it may not be unprofitable to examine some of the ideas on which their general propositions are based.

The first idea is that some recognition should be made of the readiness and sacrifice of the trade unions in giving up many of the principles and privileges which trade unionism has established for the safeguarding of the interests of its members. The next is the large contribution in men which the unions have made voluntarily to the fighting forces. A further general assumption is that labour has no voice in the conditions under which it works and is remunerated, and another, that a more equable distribution of the wealth produced by labour is desirable.

In dealing with the first aspect I have mentioned, we must go back to the situation shortly after the outbreak of war. It had then become evident that shell and other munitions of war were required on a scale hitherto undreamt of and beyond the capacity of the regular establishments to supply. Recourse was had to engineering firms of all classes, and urgency was the note of a somewhat desperate situation. Then the Government discovered that the obstacle opposed to their desire for intensified production and emergency measures was the trade unions. Promptly and wisely they called them together in what is known as the Treasury Conference of March, 1915, and they made a bargain with them. By this agreement, the general terms of which were subsequently embodied in the Munitions Act, the unions on the one hand agreed that there should in no case be any stoppage of work upon munitions and equipment of war or other work required for a satisfactory completion of the war; that in case of failure to reach a settlement of any dispute it should be referred to one of three authorities for final arbitration; and that any rules, practices or customs tending to restriction of output should be relaxed. And the Government, on the other hand, on behalf of the employers—whom, by the way, they had not consulted—agreed that firms working on munitions of war should be controlled by the Government; that their profits would be limited with a view to securing that the benefit resulting from the relaxation of trade restrictions or practices should accrue to the State; that the restoration of pre-war conditions be guaranteed by the State; that certain standards of remuneration should be paid to women, unskilled, and semi-skilled labour. There have been many expressions of praise lavished on the unions for their abandonment of their privileges.

The largest engineering trade union is the Amalgamated Society of Engineers, with a membership of 221,000, next comes the Steam Engine Makers' Society, and then the United Machine Workers' Society, and the conditions of industry between these unions and the federated engineering employers are embodied in a formal agreement made originally in 1897. This agreement was again renewed voluntarily, with only some verbal alterations, which left the provisions practically unaltered in 1907. It is true that, just prior to the war, the Amalgamated Society of Engineers terminated the agreement, but the provisions for avoiding disputes were re-enacted pending the revision of the agreement. The other signatories did not terminate but expressed a desire for revision. In effect, the terms stood as officially registering the conditions which for twenty years had been recognised as governing the industry. Let us see what these conditions were.

The first clause of the agreement sets out the general principle of employment, viz., that the employer shall not interfere with the proper functions of the trade unions, and the unions shall not interfere with the employers in the management of their businesses. Clause 3 provides that the employers and their workmen are entitled to work piecework, provided certain conditions, all favourable to the workmen, are observed. Clause 4 deals with overtime. Other clauses deal with apprentices and with the rating of skilled workmen, and provide for general alterations being negotiated locally by the men's and the employers' local associations. Clause 7, the most important clause in the document, sets out that employers have the right "to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and to pay them according to their ability as workmen. Employers, in view of the necessity of obtaining the most economical production, whether by skilled or unskilled work, have full discretion to appoint the men they consider suitable to work all their machine tools and to determine the conditions under which they shall be worked." Then follow the provisions for avoiding disputes, which set out the procedure in case of disputes, viz., individual discussion by the employer and deputations of his workmen; then, in the event of failure to agree, conference between the local association of employers and the local representatives of the trade unions; and on further failure to agree, central conference between the executive board of the Federation and the central authority of the trade union or trade unions concerned.

These privileges were fought for and gained by the Engineering Employers' Federation for the benefit of the industry, and that they were recognised as reasonable and fair is evidenced by the fact that after ten years' trial they were voluntarily and under no compulsion confirmed by the three leading engineering unions. But although the letter of the agreement stood, anyone familiar with shop practice during recent years is aware that the spirit was gone, that encroachment after encroachment was insidiously made with the full sanction and cognisance of trade union officials, that the agreement, so far from being honestly and fairly kept, was flagrantly and continually broken. Thus many of the rules, practices and customs which the Government is under obligation to see restored were established by direct violation of the terms of a mutual bargain.

The position just before the outbreak of war was that, by consistent disregard of the terms of the agreement, many of those provisions, although officially effective, had become inoperative, and these inroads on the powers of management in the shops had become so serious that, had war not intervened, the autumn of 1914 would probably have seen an industrial disturbance of the first magnitude. The employers had themselves to blame for this situation, as they had tacitly acquiesced in the abandonment of their position rather than face a general strike. Work was plentiful, prices were good, and the general outlook, barring labour, was satisfactory, so that, in view of the prosperity of the industry and the general disinclination to force matters to an issue, the process of encroachment was allowed to proceed practically unchecked.

After careful consideration of the employers' rights as agreed upon mutually with the unions, the sacrifices which the latter are alleged to have made do not seem so apparent, provided their agreement had been honestly and faithfully kept. The admission of women to the workshops and to the work previously done by men, together with the abandonment of the right to strike, are the two real concessions which have been made. The first has been qualified and hedged to such an extent that it is difficult to award any credit to a spirit which has bargained and sold a grudging consent at a price the highest it could exact. Dilution was first called for by Mr. Lloyd George in March, 1915, but no employer dared introduce it on his own account for fear of dislocation and possible strike, and as a matter of fact various strikes and disturbances took place on its introduction. It was not until nine months after, when a Commission was sent to the Clyde to secure its acceptance, that a beginning was really made in this district. To speak of the ready sacrifices of labour with these events scarcely faded from our memories is hardly a correct use of terms.

The right to strike was also abandoned, although the threat to strike is still resorted to as a peaceful persuader. In normal times this is the great and highly valued right of the worker to secure acquiescence in his demands from the employer, and in normal times its abandonment would certainly have been an undoubted sacrifice of a very real nature; but the abnormal circumstances prevailing in 1915 somewhat qualify its value. The temper of the Government towards labour was all for conciliation and appeal, the force of public opinion ran strongly against any interruption of work necessary to supply our armies in the field, and, further, both employers and employed were no longer free agents. With these factors acting, the necessity for striking and the prospects of a successful strike in view of the Defence of the Realm Act made the abandonment by the unions of this right from the point of view of sacrifice more spectacular than real.

Another special claim by the unions to consideration in reconstruction is that many thousands of their members have joined the forces. All honour to the men who did so, but these men made their choice as men, as citizens of our country, and not as trade unionists, and their sacrifice redounds to the glory of their country and cannot be sectionalised for the benefit of any organisation to which, by the accident of circumstances, they belong. Their claims are upon the nation as a whole as a part of that nation which responded to the call in the hour of need and danger. The claim of the unions in this respect is akin to that of the patriot who remained at home himself, but out of the fulness of his patriotism had given both his brothers to the fighting forces and was prepared, if the worst came to the worst, to send his old mother also.

Having briefly analysed the grounds on which special consideration is asked for the engineering unions in industrial reconstruction after the war, let us now consider some of the claims themselves which have been put forward for securing the more efficient working of the industrial machine.

The first proposal is what is termed "Control of Industry by Workers." Some very elaborate superstructures have been erected on this as a foundation in the press and elsewhere, and in order not to misrepresent the claims I will quote their formulation from two different sources. As a typical example of the statements made, no doubt in all sincerity and with a desire to promote improvement, I take one from a manifesto signed by Bishop Gore, Bishop of Oxford, and a number of other influential names, and a somewhat more definite and authoritative statement by Mr. Gosling, the president of the last Trade Union Congress. With regard to Mr. Gosling's claim for a say in the beginning and ending work, this means, of course, a say in shortening hours. The means for making the voice of labour heard as to this are already in existence in the engineering industry. As a matter of fact, it was a question which the engineering unions were about to press on the attention of the employers when war broke out, and there is little doubt that when the present conflict is over it will be at once brought forward for discussion under the regular constitutional procedure. I am not called upon to express an opinion on the merits of the question, but would merely point out that, with the machinery of the existing organisations, an effective means exists for discussing the question fully and submitting the arguments from the labour point of view, and it is not an answer to say that the power of resistance to the demand remains with the employer, and to regard him as necessarily reactionary. Employers in some branches of industry are satisfied that, with certain other conditions operative, a shorter working day might be granted without detriment, but there are other departments where it would certainly curtail output. There are economic and humanitarian arguments on both sides, and no more effective way of getting at a proper adjustment of these is possible than by the free discussion by both parties, which is provided in the procedure already established in the engineering industry.

Take Mr. Gosling's other demands. "The conditions under which we have to work." The major part of engineering is carried out in establishments supervised by sanitary authorities and by the Home Office under special regulations as to lighting, ventilation and structure, but apart entirely from the attention of these authorities, the modern employer has learned from innumerable examples that good, well planned and constructed buildings are a necessity to efficient production, and there are few employers who have not a certain pride in having their establishments such as to make the working conditions of their men as comfortable and bright as possible. Next he says: "We have a right to a voice in the conditions of remuneration." The manner in which this is accorded to the workmen in the engineering industry has already been indicated. Wage changes are the subjects of local and central conference between the federation and the unions practically every month throughout the year, and the proportion of amicable settlements is encouragingly large. The war-period provision of a final determining authority in the Committee on Production has naturally affected this machinery somewhat, but in normal times it largely satisfies the demands put forward by Mr. Gosling. Next he desires a voice as to the manners and practice of the foremen, &c. Complaints on this score when not satisfactorily dealt with on appeal to the individual firm can be carried to the same tribunal, and there can be little foundation for the grievance if it fails to secure suitable action by the employer's representatives.

It will therefore be seen that, so far as the engineering industry is concerned, it would be difficult to devise any machinery which would more effectually permit of grievances on any of Mr. Gosling's points being more thoroughly ventilated and, where well founded, remedied, or where the workers have better opportunities of bringing before their employers their claims and aspirations, or where the conditions of work have been more carefully adjusted after mutual discussion.

There is, however, an even more conclusive proof of the extent to which engineering labour already regulates its own conditions of industry in the local agreements or working rules existing between the local engineering associations and the local unions. I take, for instance, the working rules between the North-West Engineering Association and the Amalgamated Society of Engineers. These are rules made after joint discussion. They set out the conditions of overtime, Sunday work, night shifts, holidays, repairs and special travelling and outworking allowances. Together with the terms of the main agreement, these rules and similar rules throughout the country form the basis of the industrial relationship in the engineering trade, and the point to be emphasised and borne in mind is that these have been formulated and established after general discussion and modification and entered into voluntarily by the respective unions. It will therefore be seen how far from the actual fact is the assumption so widely made that labour has no voice in or control of the conditions under which it works.

I would also like to mention an aspect of the control which is not generally known outside the workshop; it is that due to the highly organised system of the trade union, viz., the control exercised by and through the system of shop stewards. These are the official trade union representatives in the shop, and their duties comprise reporting any grievances, keeping a strict eye that no infringement of trade union rights takes place, and generally the safeguarding of the interests of their union in individual shops. In many cases their functions are performed with judgment and discretion, but they exercise in almost every establishment an intangible but very real effect in moulding the management and conditions of the shop.

Leaving the domestic side, if we look for a moment at the political and administrative side of labour since the war began, we shall see how powerful the influence and control of the unions have become. The policy of the first Minister of Munitions was to depend on the union officials for securing the services and assistance of labour, and naturally he endowed these officials with important positions and as much authority as it could be considered expedient to grant. The National Labour Advisory

* Presidential address to the Glasgow University Engineering Society (slightly abridged).

Committee consists of trade unionists entirely, seven in number, and there are none of the Ministry of Munitions Committees in any way dealing with labour on which they are not represented by active and capable propagandists. During these late troublous times Mr. Arthur Henderson, himself an eminent trade unionist and acting president of the Iron Moulders' Union, has been appointed Labour Adviser to the Government. These various bodies and personalities have controlled the conditions and remuneration in a manner which cannot, from their composition, be other than favourable to labour. No section of the community has safeguarded its own interests so completely or imposed its requirements on the Government so successfully and continuously as that represented by the engineering trade unions of the country.

And this brings us at once to an aspect of labour affairs which explains much of the difficulty which surrounds the whole relationship of capital and labour. It is that the questions between them, when these are questions not only of general principle but even of technical detail, depend for their ultimate settlement not on economic but on political considerations. The power of numbers through our suffrage system makes this inevitable, and just as inevitable is the aspiration of popular government to impose by political action on the industrial side that equality which it has already established on the political side. The control of industry, however, connotes an entirely different set of ideas from that expressed by the president of the Trade Union Congress in the minds of the more advanced Socialists, the intellectuals of the movement. This section considers the questions of hours, wages and conditions mere details, and firmly advances as its programme the complete wiping away of the industrial system, the abolition of wages in the existing meaning of the term, and the substitution of Democracy for Autocracy in the workshop. This is to be done through the unions securing every worker as a member, so that they may have the entire monopoly of labour. Then will come a number of stages where the unions will be taken more and more into partnership, and the system of dual management will be developed. The unions will then become an organism embracing all the workers in any way engaged in the industry, and finally will come the stage when the complete control of industry in the interest of the producer will have been attained.

Whatever development may arise in the evolution of industrial conditions, many intervening steps must be painfully and laboriously climbed before society is ripe for such a change. It may not be out of place to indicate that a unique opportunity presented itself to the engineering trade unionists to prove the bona-fides of their demand for a share in the control of industry, and at the same time to assist the country in a tangible and practical way during the present war. The Government decided to increase the supply of shell by the establishment of a number of National Projectile Factories; the capital expenditure was supplied by the Government; the orders for shell were guaranteed; no competition could interfere to discount the efforts made; all that was asked was the administration and management. Yet no offer by any trade union to undertake the responsibility for one of these factories was made.

The question of a more equable distribution of the wealth produced by labour is one which bulks largely in nearly all programmes of industrial reconstruction. Briefly, the object of the claim as stated by Mr. Sidney Webb is the recovery by the people of what John Stuart Mill calls "The enormous share which the possessors of industry are able to take of the total produce." As indicative of the amount of this share, so far as shipbuilding and engineering are concerned, I will take the results of recent investigation by two different authorities. The first, a well-known Clyde shipbuilder, taking a statement of the dividends paid by 12 shipbuilding firms during the 13 years previous to the war, found that the average dividend of each firm varied from 12 to about 1¼ per cent., and the average of the whole number for 13 years is almost exactly 5 per cent. Dealing with the question of the share which the workmen should have, Mr. Gerald Stoney, in his presidential address to Section D of the British Association this year, states that the average capital expenditure in an engineering works per individual employed is about 200*l.* This figure was confirmed by an investigation of shipbuilding yards, which gives 185*l.*, and by the Census of Production, which gives 214*l.* per man. An analysis of the dividends paid shows them to be about 4 per cent. on the capital employed. "It means," Mr. Stoney says, "that the shareholders get about 8*l.* per year per individual employed; on the other hand, the average wages for men and boys, skilled and unskilled, is about 70*l.* per annum in normal times. This means that the worker gets between eight and nine times as much as the capitalist." Considering this from another point of view, I have taken the dividend of a large representative well-known shipbuilding, engineering, and steel company and divided the total dividend paid for 1913–14 amongst the whole of the employees, and find that this would give each employee as his share 3*l.* 6*s.* 4*d.*, or about 1*s.* 3*d.* per week. Taking 1914–15 dividend, naturally a somewhat abnormal one, the same distribution would give each employee 4*l.* 2*s.* 11*d.*, or 1*s.* 7*d.* per week.

You are familiar with the revolution which has been wrought in engineering by the introduction of the Parsons turbines, and the sequence of developments which have followed. How much of the wealth produced by that invention should be allocated to labour, and how much to the inventor? If the royalties paid to the inventor are contrasted with the wages bill on turbine construction, the proportion, I venture to say, will be found to be a surprisingly small one, and the lion's share will be with the workers, the steel founder, the machine tool maker, the turner, the fitter, and the erector.

The older economists postulated the factors necessary for the production of wealth as land, labour and capital, but there is a fourth, which we may call ability or brains, the exercise of which is certainly a form of labour but which is entirely distinct from the general acceptation of the term. "Labour in the general sense," to quote Mallock, "is a kind of exertion on the part of an individual which begins and ends with each separate task it is employed upon: but ability is a kind of exertion on the part of an individual which is capable of affecting simultaneously the labour of an indefinite number of individuals and thus hastening or perfecting the accomplishment of an indefinite number of tasks." So far I have not seen any attempt by those who clamour for a greater share of the wealth produced by industry to furnish any logical allocation of the amount of the share or even to place a limit on the amount which labour should take. Despite all theories which may be advanced this will ultimately largely depend, as Professor Marshall says, on normal distribution and exchange.

As illuminating this aspect of the production of wealth and the share of it due to the worker, it may be pointed out that the capture of the dye trade from England was not the result of effort on the part of the German workman. It was the brain and ability of the German chemical industry which brought this about. The growth of the German spelter business was due to no superior skill in the Silesian labourer; it was brought about by the exercise of those faculties, on the part of certain Germans, which reside in the few and not in the many. And that, after all, is the explanation and origin of the cry for a more equable distribution of the product of industry. Ability is found in the comparatively few, "the natural monopolists of business ability," as even Sidney Webb is constrained to call them, and its rewards are concentrated amongst them, but it rarely manifests itself without benefit to the many. Hence undue interference with its activities, the hampering of its operations, and the diminution or distribution of its reward, will tend not to a greater prosperity of the people as a whole, but to the detriment of the community.

Briefly, then, we may summarise the ground we have covered as follows:—(1) The engineering unions have not established either by their leadership of labour or their action any claims for special consideration by the community. On the contrary, in place of assisting the Government, they have increased and intensified the difficulties. (2) In place of meeting the reciprocal obligations under the Munitions Act in a spirit of helpfulness, they have failed to do so, and have haggled and bargained, delayed and contested point by point as those arose. (3) Their claim for greater control in industry is based on no definite need which is not already met, and it has not been shown that any greater measure of control than that which already exists would be productive of greater efficiency or of better conditions for the workers themselves. (4) A greater share in the wealth produced in industry by labour itself cannot be secured in the form of wages without some form of payment by result, and in many staple manufacturing industries the surplus from which any greater share could be obtained does not exist. That a share of the wealth produced by ability in the exercise of capital is capable of being diverted so as to lessen the return to ability, is however, possible. It is not only possible, but in my opinion, probable under a democratic government, and as a result of the more communistic view of the employers' obligations to the State.

Having thus discursively dealt with some of the views which are being advanced, and shown, I trust, that they must be largely qualified before acceptance, perhaps I may be permitted to give brief personal expression to some of the lines on which I believe development will take place. We must recognise that many of the so-called principles of economics must go by the board. We must approach the situation from an entirely fresh viewpoint, and we must ask that it be regarded from a similar viewpoint on the other side. For national as well as domestic reasons it is necessary that higher productivity in all branches of industry must be obtained—restriction of output, limitation of apprentices, and obstruction in the use of new methods and appliances must be given up, not only by official agreement but in actual fact in the workshops. On the other hand, the wages of the skilled workman, when he is exercising his skill, should be on a higher level, and in every department, as the direct result of greater production, an equivalent higher rate of earnings should prevail, a more definite and logical system of grading labour and determining its productive value should be adopted.

But, after all the wages are paid, the depreciation and establishment charges met, and the balance struck, there remains the profit; it is this on which, when all is said, the eyes of the unions are centred, whether they reduce it or eliminate it entirely by demands for higher wages, shorter hours or a thousand and one other claims involving additional cost, and it is from this source, where it exists, that in all probability the additional increment which is being clamoured for by the workers under various names will ultimately be obtained.

The industries of the country are no longer regarded as the property and possession of private individuals or corporations. They are regarded as public trusts whose existence in private hands is tolerated for certain benefits they confer on the community, and they must be compelled as the price of their existence to contribute more and more to the common good.

If we recognise normal distribution and exchange as assessing the value of services, then the productive effort of labour results under certain conditions in a certain wage, and no artificial standard can be preserved for any length of time. If, however, the State intervenes and says "This wage is inadequate to secure for the worker a proper standard of living, which as a unit of the nation we must insist on his having," then it is necessary to supplement the wage in some way. The employer points out that experience proves that the receipt of higher wages does not necessarily result in a higher standard of living. Foolish and irrational expenditure are only too common. Further, an increase in wages has repeatedly resulted in a decreased output due to diminution of effort, slack time-keeping, and other reasons, all seeming to point to the fact that the worker prefers an easy time with even a low standard of earnings rather than an increase of activity with increased earnings. Recognising this, we can imagine the State saying: "Since the worker is apt to spend any increase in earnings unwisely and on unessential things, since we have undertaken to secure for him an addition to his income, we shall also arrange to spend the addition for him, and as it has been obtained for the purpose of enabling him to live under better conditions, we shall spend it on the things which will achieve this result—improved housing, sanitation, pure food, education, and other forms of betterment." There still remains, however, the question of where the supplement to pay for these benefits is to be obtained. The State, having already experimented in limiting the profits of the employer, will find no insuperable difficulty in continuing the process and substituting one national need for another as the pretext for securing from the excess profits of the employer, where they exist, a provision towards the welfare of the worker apart altogether from the workers' earnings. Naturally, the Government would have to earmark this amount for industrial betterment. In no other way than by some such method can I see the general participation of the workers, apart from their wages, in the distribution of the wealth created by industry.

I look for this readjustment of the position between the employer and worker being carried out, if not under Government direction, at least under the initiation of whatever authority is set up by Government for dealing with labour. The engineering unions will seek to have established their right to the restitution of those rules, customs and practices abrogated under the Munitions Act. Their right will be recognised by the Government, but the danger to the industrial life of the country, if these rules, customs and practices are insisted upon, will be pointed out. The unions themselves will recognise that a complete restoration of these rights could not be insisted upon in view of the enlightenment of public opinion, and they will carry out their familiar policy of bargaining and trading the abandonment of certain of their rights for the greatest concessions they can obtain from the employers in the form of shorter hours or other benefits. The Government control of industry will never be wholly relaxed; the chances are all in favour of its being increased and exercised in an increasingly democratic fashion. I do not anticipate any revolutionary changes in either the organisation or the administration of the industry, but certain palliatives will doubtless be introduced by the Government against extreme action on either side. I do anticipate and I do hope for very great changes on the employers' side, a more intelligent interest in the social and economic problems affecting the industry, in the teaching and training of apprentices, more regard for the efficient equipment of their establishments, the wider application of science to the daily problems of the workshop, closer co-operation and federation of industry.

So far as is possible, I think an extension of the shop committee system is on the right lines. If each establishment had a committee representative of its various departments meeting regularly with the official management to discuss shop conditions and shop questions of all kinds I believe it would tend to better relations and greater efficiency. Much depends of course on the personality of the committee and on the attitude and tact of the management at their joint meetings. Election to the committee should be by ballot, and I would advocate that the members of the committee should be paid a fee for attendance by the firm. As against this the firm should have the right of nominating a candidate in whatever departments they might desire, as it might be possible that the workmen would prefer to elect a nominee of the firm rather than, say, a nominee of the trade union, and the election being by ballot would permit of this being done without untoward consequences to them. Arrangements of this kind are already in existence, and in cases where they have not been successful it will generally be found that the reason is from want of tact on the part of the management.

I would also like to express the personal opinion that the employer of to-day stays too long in business. He should leave off actual administration earlier and give place to younger men. A very eminent business man has expressed the opinion that much of the political power which trade unions have acquired is due to the members of the engineering industry being too busy and too long engrossed with their individual affairs to give time to attend to their political interests. An earlier release from actual administration and the application of the knowledge gained in another sphere for the benefit of the industry as a whole was his remedy for much of the trouble which, in his opinion, the employers have brought upon themselves.

THE JAPANESE NAVY.—Ideal weather, says *The London and China Telegraph*, favoured the launch of the battleship Ise, which took place recently at the Kawasaki Dockyard. The ship took the water without the slightest mishap. This latest and substantial addition to the Japanese Navy is a battleship of 31,260 tons displacement; she will have a speed of 23 knots. Her keel was laid on May 10, 1915, and it is expected that she will be completed and delivered to the Navy before December this year. The principal armament of the Ise will be twelve 14-in. and twenty 5½-in. guns; she will also be fitted with four torpedo-tubes.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

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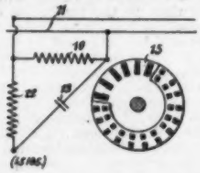
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

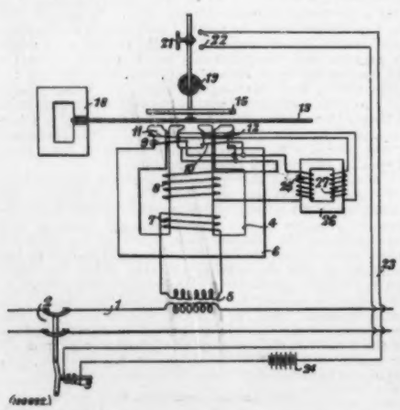
ELECTRICAL APPARATUS.

15,186/15. The British Thomson-Houston Company, Limited, London (*General Electric Company, Schenectady, U.S.A.*). **Alternating Current Motors.** (4 *Figs.*) October 27, 1915.—The invention relates in particular to condenser induction motors adapted to be operated from a single-phase supply. The main primary winding 10 of a condenser induction motor is connected directly across the mains 11. An auxiliary primary winding 12 is arranged on the stator member of the motor and is displaced at an angle of 90 electrical degrees in space from the winding 10. The two windings 10 and 12 are arranged on the stator member just as the two primary windings of a two-phase motor. A condenser 13 is connected in series with the auxiliary primary winding 12, and the condenser and winding 12 are then connected across the mains 11, or across the terminals of the motor. The circuits of the two primary windings 10 and 12 are thus connected in parallel across the mains 11. The presence of



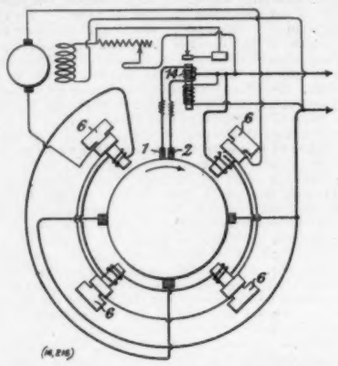
the condenser in the circuit of the auxiliary primary winding 12 produces a leading current in this circuit, which sets up a flux out of time phase with the flux set up by the current in the main primary winding 10. The two fluxes thus set up by the currents flowing in the two primary windings are displaced in space and time phase and produce a shifting magnetic field of well-known characteristics. The head of the current flowing in the circuit of the auxiliary primary winding can be so proportioned by the suitable design of the condenser as to correctly compensate for the lag of the current flowing in the main primary winding, whereby the motor operates with approximately unity power factor. The secondary winding is carried by the rotor member 15 of the motor and is a short-circuited winding having much higher impedance when the slip is large than when the slip is small. (*Accepted November* 1, 1916.)

100,892. The British Westinghouse Electric and Manufacturing Company, Limited, London. Electric Relays. (1 *Fig.*) July 12, 1915.—This invention relates to electrical protective devices, and particularly to time-limit relays of the induction motor type. The circuit 1 is provided with a circuit interrupter 2, a tripping device 3 therefor, and a time element relay 4 supplied with current from a transformer 5 which is connected in the circuit 1. The relay 4 is provided for controlling the circuit of the tripping device 3 and comprises a magnetisable core 6 having a main winding 7, a secondary winding 8 and four auxiliary windings 9, 10, 11 and 12 disposed thereon. An armature 13 is adapted to turn between a magnetisable member 15 and the pole pieces of the magnetisable core



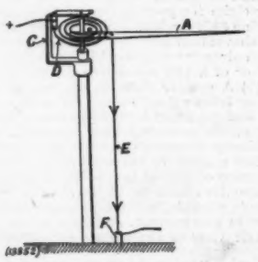
member 6. The armature 13 is adapted to also turn between the poles of a permanent magnet 18 for the purpose of retarding its motion. A spring 19 is connected, at one end, to the shaft carrying the armature 13, and, at its other end, to a stationary member. A movable contact member 21 is mounted on this shaft, and is adapted to engage stationary contact members 22 that constitute the terminals of a circuit 23, which consists of a source of electromotive force 24 and the winding of the tripping device 3. The secondary winding 8 of the relay 4 is connected in series with a winding 25 that is disposed on a relatively small transformer 26, the magnetisable core member of which is easily saturable. The auxiliary windings 9 and 10 are connected in parallel, and the circuit, thus constituted, is connected in series with the windings 8 and 25. The auxiliary windings 11 and 12 are connected in parallel with a winding 27 that is also disposed on the core of the transformer 26. The core member of the transformer 26 is of such size that it is adapted to become magnetically saturated when predetermined currents traverse the winding 25. (*Accepted November* 1, 1916.)

14,216/15. M. Walker, Manchester. Dynamo-Electric Machines. (7 *Figs.*) October 7, 1915.—This invention relates to dynamo-electric machines of the commutator type. The invention consists in the use, on one or more brush-arms which collect current under conditions similar to those obtaining at other brush-arms, of a divided brush, the parts 1, 2 of which



are connected to a magnetising coil 14, so that, in the event of an uneven distribution of the current under the divided brush the magnetising coil operates relay mechanism controlling the excitation of the commutation poles 6 of the machine so as to counteract the disturbance which is causing the uneven current distribution. (*Sealed.*)

13,852/15. Marconi's Wireless Telegraph Company, Limited, and H. A. Ewen, London. Hot Wire Ammeters. (6 *Figs.*) September 29, 1915.—The drawing shows the apparatus in its simplest form. A is an indicator arm having an arbor mounted in a frame C, to which is secured one end of a spring D, the other end of which is secured to the arm A. E is a metal filament or wire, one end of which is connected to the arm while the other end is connected to a fixed support F. The arrangement is such that the tension of the filament tends to bring the



indicator into the position in which the point of attachment of the filament to the arm is as near as possible to the support F, while the spring tends to turn the arm away from that position. When, therefore, an electric current is passed through the filament, the latter will expand owing to its rise in temperature and allow the spring to turn the arm, and the angle through which it is so turned can be read upon a scale which may be graduated to show the strength of the current. (*Accepted November* 8, 1916.)

101,914. T. O. Callender and Callender's Cable and Construction Company, Limited, London. Electric Cables. (3 *Figs.*) February 28, 1916.—This invention has for its object to prevent or minimise liability of breakdown of cables by reason of any undue pressure rise that may be set up therein by resonance or other cause. For this purpose the cable is provided with one or more lengths or sections so constructed that the dielectric strength thereof is less than that of the remaining portion of the cable, so that the dielectric loss which takes place

in such length or section, and which is normally greater than in the remaining portion of the cable, will be increased in the event of the cable being subjected to an increase of pressure from any cause, so as to relieve such increased pressure and in this way prevent breakdown of the cable. The drawing shows in cross-section a safety section of cable in which *c* represents the insulated core thereof and *d* ribs upon the metal sheathing *e* surrounding such core. The ribs *d* serve to dissipate the heat due to the elimination of the pressure rise. (*Accepted November* 8, 1916.)

GAS-ENGINES, PRODUCERS, HOLDERS, &c.

100,055. Maschinenfabrik Oerlikon, Oerlikon, Switzerland. Gas Turbines. (2 *Figs.*) February 3, 1915.—According to this invention, the vanes are made from shaped bars *c* of a uniform section, which corresponds in section to that of the finished blades at the outer ends of their operative surfaces, and are subsequently so milled or planed off on one side that the ratio of widening of the ducts between assembled vanes is uniform throughout their whole length. Fig. 1 shows a diagrammatic side view of a stator composed of an inner ring *a* and an outer ring *b*, into which the radially disposed vanes *c* project with their inner and outer ends respectively. The distances *g*, *h*, *i*, separating the vanes at the points corresponding to the various circles *d*, *e* and *f* differ from one another, and therefore the width of the ducts bounded by the vanes also varies. Fig. 2 represents a section through the vanes *c*, at the points corresponding to the circle *f*. The hatched surfaces indicate the sectional dimensions of the vanes *c*. The sectional area of the duct for the pressure medium is bounded by the lines *k* and *l*. The width of the duct at its narrowest part is indicated by *m*, and that at the outlet by *n*. At the points corresponding to the circle *e*, the distance between two adjacent vanes has diminished to the dimension *h*. The sectional area of the duct is bounded by the lines *o* and *p*. The width of the duct in the narrowest part is indicated by *q*, and at the outlet by *r*. Turning to the circle *d*, the distance

Fig. 1.

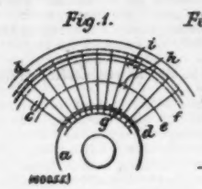
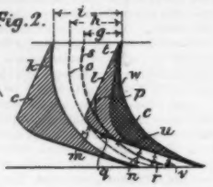


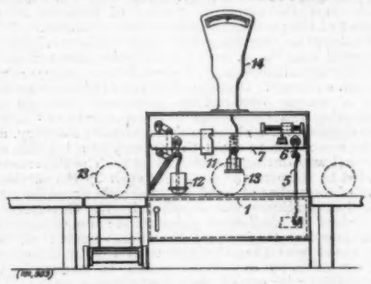
Fig. 2.



separating the vanes diminishes to *g*. The sectional area of the duct is bounded by the lines *s* and *t*. At its narrowest part, the width of the duct is indicated by *u*, and at the outlet by *v*. The lines *t*, *p* and *l* which, with the line *w*, form the sectional dimensions of the vane *c* at the various points corresponding to the circles *d*, *e* and *f*, are selected so that the ratios $\frac{u}{v}$, $\frac{q}{r}$ and $\frac{m}{n}$ are as nearly as possible equal. (*Accepted November* 8, 1916.)

MISCELLANEOUS.

101,903. Henry Pooley and Son, Limited, and J. Dobson, Birmingham. Weighing Scales. (4 *Figs.*) January 27, 1916.—This invention has reference to weighing scales for testing shells. The weighing scales comprise a platform 1 mounted on weighing levers of a low power, the levers and platform being provided with a relieving mechanism. The weighing levers are connected by the rod 5 and link 6 to a steelyard 7, the free end of which is disposed between two cams, which are adapted to lock the steelyard in the position of equilibrium, the cams being operated by a hand lever. Mounted on the steelyard 7 is a sliding poise weight 11 and a suspended poise weight 12 to counterbalance the shell 13 placed on the platform 1. Connected

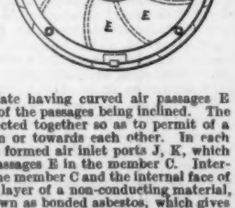


to the steelyard 7, and preferably about midway in the length thereof, is an automatic indicating mechanism 14, the mechanism 14 and its indicating pointer being so arranged that when the steelyard 7 is in the position of equilibrium the pointer occupies a mid-position on the chart against which it indicates. This arrangement of the mechanism 14 and the pointer permit of a visible movement of the pointer in either direction from the mid-position, thereby indicating within determined limits the amount by which the shell 13 being tested is in excess of, or deficient of, the weight of the standard shell, and automatically indicates to the weigher if the shell is to be passed or condemned. (*Accepted November* 8, 1916.)

101,918. J. D. Thomson and G. Thomson, Edinburgh. Friction Gear. (2 *Figs.*) March 17, 1916.—The present invention refers to air-cooled friction mechanism more particularly intended for transmitting motion to winding reels in which the material to be wound is fed to the reel at a constant speed, whilst the speed of the reel itself is gradually reduced in proportion as its diameter increases, so as to keep a uniform tension on the material. The friction mechanism consists of two side members A, B, and a central member C. The two side members A, B, which form a casing for the central member C, are loosely carried on a shaft D, which may be connected direct, or through gearing, to the reel or reel spindle. The central member C, which is keyed to the shaft D, is in frictional contact with the two side members A, B,

Fig. 1.

Fig. 2.



and consists of a double plate having curved air passages E formed in it, the outer ends of the passages being inclined. The two side members are connected together so as to permit of a lateral movement away from or towards each other. In each side member A, B, there are formed air inlet ports J, K, which communicate with the air passages E in the member C. Interposed between the faces of the member C and the internal face of each side member A, B, is a layer of a non-conducting material, preferably that material known as bonded asbestos, which gives a maximum coefficient of friction with a minimum pressure, and which at the same time is a good non-conductor of heat. Means are provided for adjusting the pressure between the two side members A, B and the central member C, such, for example, as the spring N, on the shaft D. (*Accepted November* 8, 1916.)